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ABSTRACT

This manufacturing technology curriculum involves students in learning problem-solving, communication, team building, quality control, safety, math, science, and technical skills. The document begins with a section on implementation, which gives background information on the purposes and development of the curriculum, explains its rationale, describes strategies for its implementation, and provides special hints for teachers. The curriculum itself consists of eight units that include information related to various phases of manufacturing: measurement; print interpretation; layout and inspection; occupational safety and health; business economics; product and process control; skills marketing, with worksheets; and quality in manufacturing. Each unit is composed of activities that increase student involvement and interest through teamwork strategies and lab exercises. The curriculum may be used as a complete course of study or individual units may be incorporated into an existing course. Each unit is prefaced with a table of contents, a reference sheet for figures, and a listing of the unit goals. Each activity is organized into 12 parts: activity description; rationale; outcomes; materials and resources; safe practices; instructional strategy; integrative skills; information sheet; learning check; student activity sheet; alternative strategies; and the learning performance check. An appendix contains the Illinois State Learning Outcomes Analysis. (NLA)

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**Illinois
Manufacturing
Technology
Curriculum**

**Illinois
State Board of
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Adult,
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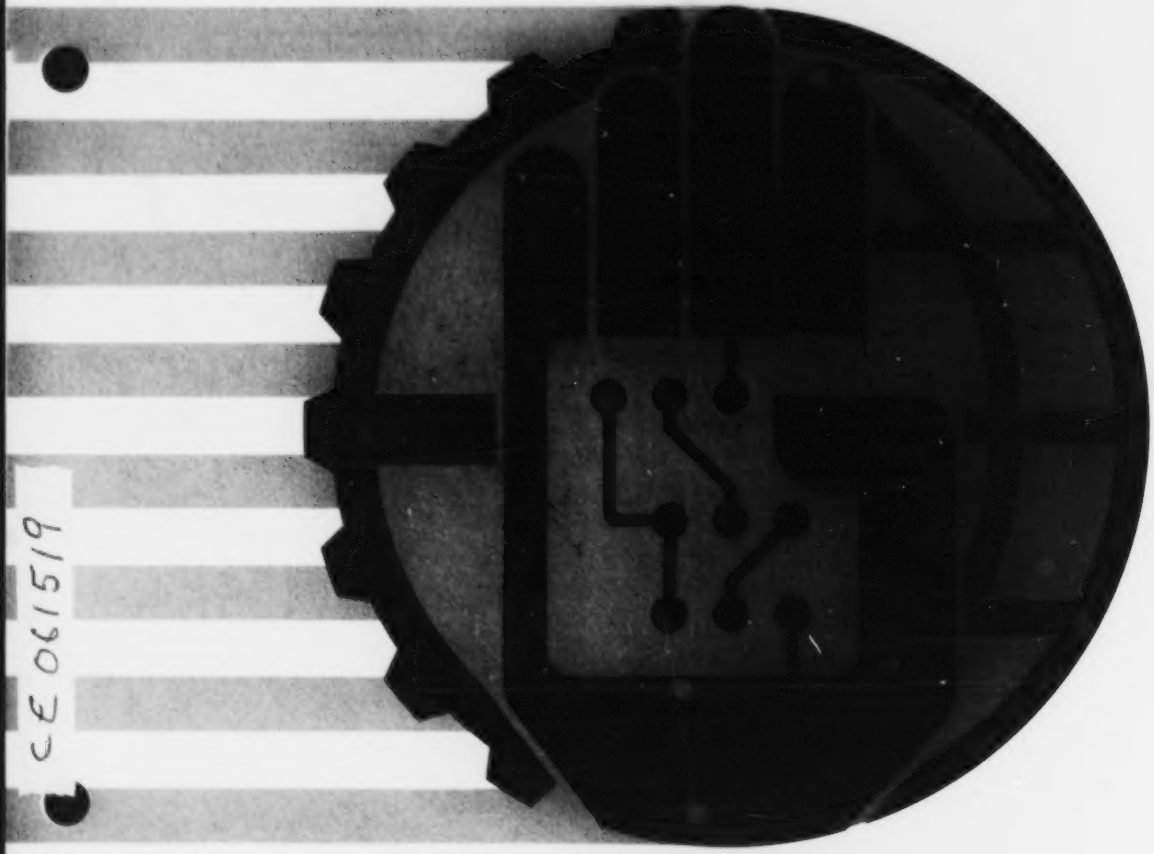

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MANUFACTURING
TECHNOLOGY
CURRICULUM

ILLINOIS
STATE BOARD
OF EDUCATION

DEPARTMENT OF
ADULT, VOCATIONAL
AND TECHNICAL
EDUCATION

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PLAC 23D

IMPLEMENTING THE MANUFACTURING TECHNOLOGY CURRICULUM

Computer integrated manufacturing, statistical process control, just-in-time inventory control, ergonomics, and participatory management are just a few of the concepts currently in use in modern manufacturing. If Illinois firms are to remain competitive in a rapidly advancing global marketplace, they must have a well-educated workforce capable of functioning in this "high tech" environment. Career opportunities in manufacturing are virtually limitless for a person who can apply complex math and science skills, can communicate effectively, possesses good self-esteem and interpersonal skills, is technologically literate, and has a technical aptitude. Illinois educators are currently faced with the challenge to prepare students for manufacturing careers in the twenty-first century.

In January of 1989, eleven representatives of manufacturing across Illinois met at Motorola in Schaumburg. This Manufacturing Technical Committee was assembled to advise the Illinois State Board of Education and Northern Illinois University concerning the skills needed by employees for work in today's manufacturing occupations. These business leaders stressed concepts such as problem solving, communication, team building, quality control, and safety. They also stressed an ability to transfer complex math and science competencies to the workplace and a desire to continue learning new skills as constant change dictates. Of course, technical skills, though becoming more broad in nature, are still important. In response to these needs, the Manufacturing Technology Curriculum was conceived.

Written by innovative classroom teachers, the curriculum attempts to involve the student in the process of learning these skills. Students take control of the planning and decision making often functioning as teams. Designed to complement the Production Technology curriculum (developed as part of the Illinois Plan for Industrial Technology Education), the Manufacturing Technology Curriculum stresses student problem solving in all aspects of modern manufacturing. Through laboratory activities, simulations, and computer assisted instruction, students experience all aspects of manufacturing planning and production often while producing a product. Specific machine skills (defined through Education for Employment task lists) can be stressed during laboratory activities. This curriculum provides a good foundation for advanced studies in manufacturing at the community college level.

Classroom teachers were also involved in testing this curriculum with positive results. These same teachers provide hints on how best to use the curriculum in the section titled "Strategies for Implementing the Manufacturing Technology Curriculum." In a final review of the curriculum, the technical committee representatives verified the appropriateness of this material.

Now the challenge is yours. The material has been developed and tested. You have received your copy. I urge you to review the manufacturing employment opportunities in your community and see if this curriculum can help you prepare students to take advantage of these opportunities. The stability of Illinois manufacturing is dependent upon the quality of our labor force. This curriculum was developed to help you meet this challenge!

RATIONALE

The rapid pace of technological change in manufacturing processes and operations has brought about the need for upgrading and restructuring our traditional vocational and industrial education programs. Because of these changes, industries are demanding new and upgraded skills of the students graduating from our programs. Some of our existing programs have moved forward and have incorporated necessary change in order to keep step with current technology and techniques and better address industry demands. However, these programmatic moves and changes have brought about additional concerns regarding the proper methodology to be used to deliver the upgraded information to the students. To meet industry demands, the educational needs resulting from technological change, as well as the concerns regarding delivery of upgraded programs, a new manufacturing curriculum has been developed to be incorporated into introductory or upper-level manufacturing courses in your high school--**the Manufacturing Technology Curriculum.**

As educators, researchers, technologists, industrial liaisons, and global citizens, we share a common interest in effectively meeting the demands and challenges of the future and in preparing our students for the world of work in manufacturing industries. Today's manufacturing personnel are no longer faced with a work environment emphasizing machine operating or mechanical skills. Progressively, computer-controlled machines perform most of these tasks faster and better. Today's workers perform higher-order human interaction skills. Manufacturing personnel are increasingly solving group problems which require increased abilities in mathematics, the sciences, and computers. Moreover, the criteria for successful modern factories, along with the skills needed by their workers, are different from a decade ago. These skills should be initially taught in high school manufacturing courses.

The Manufacturing Technology Curriculum has been created and designed to provide these skills by bringing high school course offerings in line with technological changes in manufacturing. The curriculum is not traditionally skill-specific, but it is very adaptable, making it useful to introductory as well as advanced manufacturing courses in any type of laboratory with any kind of equipment. The curriculum is activity based and offers a number of activities which may conform to your existing units and which replicate the manufacturing environment, suggesting ways students can learn the tasks demanded by industry.

Our traditional programs still possess many functional aspects. Students are motivated by laboratory-centered activities. They develop hands-on skills, and learn to perform basic machine operations. However, if our programs are to survive, they must be updated to reflect and integrate new technology and progressive manufacturing techniques. **The Manufacturing Technology Curriculum** is designed to complete and enhance existing programs in just this way. In fact, its greatest strength is that it incorporates the functional advantages of current programs with the necessary updating found in more analytical group activities. These activities also adapt to the needs of industry as well as the abilities and resources available to the instructor and students.

The current literature tells us that what the workers of the future need are skills in areas that we have not traditionally taught in an organized way. The state of Illinois has a large concentration of industry, including the home offices of major corporations. One such major corporation describes their employee of the future as needing the following skills and as being "a team member, a producer, a learner, a decision maker, a communicator, a sharer of ideas, trustworthy, responsible, and accepting of change."

It is the intent of **the Manufacturing Technology Curriculum** to help you and your students achieve those work skills of the future. As one reviewer of the curriculum put it,

> If you are the type of educator who is concerned with helping young people cope with change, learning to learn, learning to work cooperatively with others, learning to make and to follow through on decisions, and finally, accepting responsibility for making those decisions, then this manufacturing curriculum is for you!

STRATEGIES FOR IMPLEMENTING THE MANUFACTURING TECHNOLOGY CURRICULUM

The Manufacturing Technology Curriculum consists of eight units which include information related to various phases of manufacturing. The information is provided on computer disks and can be printed out according to the needs of the user. Each unit is broken down into a series of activities which are designed to increase the level of student involvement and stimulate student interest through the use of lab exercises and teamwork strategies.

The Manufacturing Technology Curriculum may be used in its entirety as a complete course of study, or individual units may be adapted so that they may be incorporated into an existing course. Each unit is prefaced with a table of contents describing the activities which are included, a reference sheet for figures (i.e., drawings, graphs, worksheets), and a listing of the unit goals which are to be achieved by the students.

Each activity within the various units of study is organized into twelve parts. These include the activity description, rationale, outcomes, materials and resources, safe practices, instructional strategy, integrative skills, information sheet, learning check, student activity sheet, alternative strategies, and the learning/ performance check. Each of these parts will be explained in more detail in the following paragraphs.

The activity **Description** gives a brief overview of the information and exercises which will be presented to the student.

The activity **Rationale** explains why it is important for students to study the information presented in the activity and how it relates to the manufacturing industry.

The activity **Outcome** provides an explanation of what the students will be able to do upon successful completion of the activity.

The **Materials and Resources** section is a listing of tools, machines, and materials which may be needed to complete the student activities. This section also includes references for resource materials (i.e., books, pamphlets, films, videos, computer software), which may be used to supplement the information being presented to the students. Some of these materials may be available through your school, while others may need to be purchased or requested on free loan.

The **Safe Practices** section gives recommendations for safety precautions which should be observed by the students during the activity. In some cases, safety demonstrations and safety tests may be given to the students to minimize the development of potential hazards during lab activities. Safe practices should be followed according to the requirements of your school and lab safety policies.

The **Instructional Strategy** section gives the teacher some suggestions on how to present the material in the activity. This may also include some helpful hints on the preparation of activities or special instructional techniques used for the exercises.

The **Integrative Skills** section is a checklist of generalizable skills the student will be developing and learning during the activity. Many of the activities reinforce academic competencies, interpersonal skills, computer skills, and problem-solving and decision-making skills. The integrative skills provide a means for the teacher to emphasize the attainment of those competencies which support the State Goals for Learning. See Appendix. These same competencies are demanded by potential employers in manufacturing occupations.

The **Information Sheet** contains all the enrichment materials related to the topic of the activity. The information sheets may be duplicated and handed out to the students to read and review. Supplemental information, such as additional handouts or textbook assignments, may also be used to enhance the activity. Graphs, drawings, and data sheets may be included in the curriculum packet as part of the information. These sheets may be enlarged and duplicated as needed for handouts.

The **Learning Check** section is an assessment of the students' understanding of the information sheet. The material in this section may be used as test questions or as review topics for class discussion. Once again, the material in this section may be adapted to meet the needs of the students.

The **Student Activity** sheet is one of the more important sections of the activity. This section is used to get the students actively involved in either a lab activity or a team-oriented exercise. The activity sheet gives an explanation of the exercise and provides the instructions necessary for the students to complete the exercise. The activity sheet may provide project ideas or offer suggestions for resources and materials to be used. In some cases, a complete, detailed exercise may be included, such as a mass production project. However, the teacher may adapt or enhance the activities to meet the needs of a particular type of class. Changes may also be necessary, depending on the type of equipment and physical facilities at your school. Drawings or worksheets to be used with the activity may also be included in the curriculum packet. These sheets may be enlarged and duplicated as needed for handouts.

The **Learning/Performance Check** sheet offers several recommendations for student evaluation during and upon completion of the activity. The learning check section may be used as part of the evaluation, along with the evaluation of the students' participation and performance. The students could also be asked to evaluate the activity to help determine what changes might be needed for improvement.

This is a general overview of **the Manufacturing Technology Curriculum**, which has been designed to give your students a higher-level understanding of manufacturing technology through a series of activities involving teamwork, problem solving, and lab exercises. You will find that the flexibility and adaptability in the curriculum materials will be of great help in the implementation of these activities at your school.

HOW DO I START?

Whether you are looking merely to include more realistic activities into your existing course or change completely to industry-prescribed manufacturing activities, **the Manufacturing Technology Curriculum** has much to offer. One of the main advantages of the curriculum is the flexibility and adaptability of its application. Although there are eight major areas in the curriculum, it does not have to be used in its entirety. Nor does each section of each area have to be used.

In deciding how to use **the Manufacturing Technology Curriculum**, perhaps the best way to start is to get a global overview of the curriculum. This can be done by reading through the curriculum. Yes, it is very lengthy and contains a great deal more information than could be covered in one semester, but by reading through the curriculum you will be able to do two things: (a) eliminate those sections or units that may not be adaptable or appropriate to your particular situation, and (b) identify which concepts and ideas you want to incorporate into your course.

In deciding if the units are applicable to your program, it can be especially helpful to review the unit goals found at the beginning of each unit and work from there. Also, along with the goals are the activities related to the goals.

Next, take a look at each activity. Each activity is self-contained, that is, it has the basic essentials (lesson essentials) within each activity. The table of contents for each unit annotates each activity to make it easier to decide which activities you are interested in looking at further. Each activity also has a title page which, in addition to including the goals for the unit, lists additional resources or materials recommended for instruction preparation.

A Student Information Sheet is provided for each activity and although this sheet is the only necessary reading for the activity, instructors may wish to supplement with additional lecture/discussion, media, or materials. Also, in addition to listing information, materials, and skills to be taught, each unit in this "user friendly" curriculum offers some sort of assessment tool for that lesson. The tests and quizzes included in the curriculum passage can be very effective and helpful in saving valuable time in development, and our field testers found student performance on the assessment tools to be even better than expected--perhaps partially due to the organization of the curriculum and the ease with which it can be incorporated into existing programs.

After reviewing the entire package and those units and activities that would be appropriate for your course, you might then rough out an outline containing lessons from particular units you intend to use. Next, place the lessons in sequence according to when and where they would fall during the semester.

In terms of actual implementation, one field tester reported:

> After handing out the information to the students, I discussed the unit description and explained the outcomes which were to be met by the students. I than handed out the information sheets for the students to read. We held a class discussion on the information and I proceeded to hand out and discuss the activity which was to be used with the unit. . . . In some of the units, I supplemented the information with textbook material or other resource materials which I felt were important to the topic being studied.
>
> I also used some of the recommended videos and computer software which I found to be good. . . . After the students had completed the activity or activities which were required for the unit of study, we reviewed the information in a class discussion and evaluated the activities to determine what worked well and what areas needed to be improved. The students were then tested on the information in the unit. (Sons, Rolling Meadows High School, Rolling Meadows)

The field tester continues:

> The new manufacturing curriculum has been a very positive experience . . . for myself and, more importantly, for my students. It has been much easier to implement than other new units or courses of study I have tried in the past. I feel that this curriculum will be an essential part of the development of our new technology program and will help us move in the right direction in preparing our students for present and future careers. (Sons, Rolling Meadows High School, Rolling Meadows)

In commenting upon implementation in his classroom, another field tester offers this assessment:

> I had decided to field test the curriculum in a mass production class. Everything in the course was centered around the mass production technique. As a product, I chose to make a cannon. The students did all the planning, organization, and sequencing of the project. Later, they cast and machined the parts, assembled the pieces, and mounted the cannon to a wooden base. At the end of the project, we even packaged the finished product. All of our work, decision making, and problem solving (of which there was a great deal) were accomplished on a team basis.
>
> I found the students to be highly motivated by the product and the techniques offered by this curriculum. I have never had a class that worked so well together in accomplishing the tasks in all my 22 years of teaching. I attribute this to a great extent to the quality of this **Manufacturing Technology Curriculum**. (Verstraete, United Township High School, Moline)

As the above comments reflect, **the Manufacturing Technology Curriculum** is designed with both the teacher and the students in mind. Adaptability, flexibility, and ease of implementation are built into the curriculum. All you have to do to get started in adapting **the Manufacturing Technology Curriculum** into your classroom is simply to pick it up and begin reading. All the rest will follow.

SPECIAL HINTS TO TEACHERS

The Manufacturing Technology Curriculum is self-contained, flexible, and adaptable. Complementary to existing programs, one of the attractive features of the curriculum is its breadth of scope. This breadth allows teachers to play ahead and search out any additional resource materials. In this way, teachers might establish a library of videos, computer software, and project ideas to choose from as they adapt the curriculum to meet the needs of the students.

Teachers might also adapt the curriculum to include some team-teaching experiences with other technology areas or involve their school's business area during the units on business economics and marketing. In one field tester's classroom, students used the curriculum to design and construct a project. After analyzing the finished product, and they invited the marketing class to test and evaluate their product. This outside interaction gave students some unique input from the perspective of a business class.

Regional industry is another resource that is available to teachers. A Winnebago (Illinois) field tester found local businesses to be very supportive in both time and materials in the assimilation of these curriculum activities into his manufacturing courses. (Ernie Johnson, Winnebago High School, Winnebago)

Field trips which relate to the various units of study can also help give students a more realistic picture of manufacturing technology.

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UNIT GOALS

1. Describe measurement's role in various manufacturing departments. (Meas.002, .009)
2. Identify types of measurements taken in manufacturing. (Meas.002, .003)
3. List characteristics of quality measuring tools and select appropriate measuring devices for measurements. (Meas.009)
4. Describe the purpose of measuring systems and convert units from one system to another. (Meas.008)
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6. Distinguish between and apply the concepts of precision, accuracy, and tolerances. (Meas.001, .009)
7. Apply measurement concepts to production activities in order to solve problems of who, what, when, where, how, and why. (Meas.002)
8. Describe future trends and technologies in measuring devices affecting manufacturing. (Meas.006, .007)
9. Describe common measuring errors and correct measuring practices. (Meas.005)
10. Identify elements and calculate costs of measuring. (Meas.001, .005)

PREFACE

The abilities to make and interpret measurements are basic, but essential manufacturing skills for many shop activities, especially measuring, print interpretation, layout, and inspection. The purpose of this curriculum is to apply these abilities in a broad context, not to teach them as specific tool skills.

The purpose of this section is to provide suggested activities which students should be proficient in prior to some of the advanced activities of this curriculum. These are introductory activities intended to build proficiency with measuring and layout tools. Ample lesson materials exist for these activities, so only their self-descriptive titles are mentioned here. Fully developed activity plans are available in a text entitled, CAM (Computer Automated Manufacturing), Illinois State Board of Education, 1987. (Can be ordered through Curriculum Publications Clearinghouse, Western Illinois University, Macomb, Illinois.)

Instructors should consider other possible measuring activities applicable to their lab or specific course. Measuring concepts and activities covered in this list are for machining metals. A manufacturing course might include or center around woodworking, plastics, etc.

SUGGESTED ACTIVITY	ACTIVITY NUMBER IN AUTOMATED MANUFACTURING
PERFORMING PRECISION MEASUREMENT	
Measure Parts with Semiprecision Measuring Tools	# 27
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Inspect Keyways	# 35
Measure Gears	# 36
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ACTIVITY NUMBER MEAS.001

PURPOSES AND USES OF MEASURING SYSTEMS

Description:

A broad review of the use of measurement in manufacturing covering its purposes and measuring systems. Students read an information sheet, complete an individual worksheet, and participate in team activity. In activity, groups consider general measuring problems and propose solutions.

Rationale:

Before application activities, one should possess a basic understanding of measurement concepts and their uses in manufacturing.

Outcomes:

Students review or are introduced to basic measurement concepts including:

1. Defining measurement and identifying measured properties.
2. Contrasting semiprecision and precision.
3. Describing dimensional measurements.
4. Identifying dynamic measurements.
5. Explaining accuracy in measuring.
6. Defining tolerances.
7. Listing advances in measuring technology.

Tools, Materials, Machines, and Resources:

1. Automated manufacturing. (1987). Springfield, IL: Illinois State Board of Education. (Units 27-48)
2. Olivo, C. T. (1987). Machine tool technology and manufacturing processes. Albany, NY: C. Thomas Olivo Associates. (Unit 2)
3. Measuring Tools Explained (Video Series). (1984). Garden City, NY: Bergwall Productions.

Instructional Strategy:

Teacher reviews fundamentals of measurement. Students read information sheet and complete worksheet. Groups of 3-5 students discuss and develop answers for activity sheet. Groups randomly picked to explain one of their answers to rest of class, followed by class comments.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Student Information Sheet Number: Meas.001

Measuring is determining the actual size, degree, or amount of something in units of a measurement system. Manufacturing personnel measure many things including dimensions, weight, volumes, pressures, and speeds. Physical measurements are used to describe, construct, or control many elements in manufacturing from layout to final inspection.

A clear understanding of measuring is necessary for those in production. Without measuring, large-scale production would be impossible. Every part would have to be made individually; its size would be painstakingly determined by tracing, transferring, "eye balling," or feel. Mass production requires fast and accurate measuring. Very little could be mass produced or precision built without accurate measuring tools. Space shuttles, compact laser disc players, motorcycles, and almost every other complex mechanism would not exist. Technologies could not move forward.

The more precisely a part is made, the more it costs because of extra time, expensive machines, and costly precision measuring tools. Some parts require those extra production costs; most do not. Depending on the part, the degree of precision varies. Precision measurements are made to within +/- 0.001" (+/-0.02 mm) or closer, using precision instruments including micrometers, vernier calipers, optical comparators, dial indicators, various gages and laser beams. Some precision measurements are taken in microinches [0.000001" (0.00002 mm)].

Semiprecision measurements are taken when close to exact size are not critical. This is considered in a range not less than +/- 1/64" (0.397 mm) or 1/2 degree. Since these types of measuring are done quickly with inexpensive tools, they save money. A general rule is to use the least precise measurement necessary. Some semiprecision measurements are made with rules, transfer instruments, and combination squares.

Decisions are made from measurements. The machinist must know how close a part is to a given dimension. Workers must determine the quantities of on-hand materials. Measurements answer many questions such as, "How many parts can be made out of a given piece of stock?"

Measurements convey information. Being a form of communication, they need to have standardized meanings, understandable by anyone reading them. Standardization is accomplished through measuring systems. Students should be familiar with two systems, the SI metric and the inch-pound [United States Customary System (USCS)]. Measurements in one system's units can be converted to the other's.

The metric system is used in 90% of the world. North America predominantly measures in customary units. As the United States increasingly competes in a "global economy," more U.S. companies are using the metric system. Metric units have two key advantages: they are better for making calculations, and they easily convert to other units (example: changing meters into kilometers or kilograms into grams). These things happen because metric units are multiples or divisions of 10. The customary system does not change units as easily, since there are 12 inches in a foot, 3 feet in a yard, and so on.

Many things from light to time can be measured, but the basic units dealt with in manufacturing measure dimensions, mass, speed, fluid pressures, and moving volumes. Measurements such as area and volume can be calculated from dimensions.

Advances in manufacturing technologies include progress in measuring. The use of vision measurement is increasing because it's quick and adapts to automated systems. Lasers are very accurate, but require timely setups. Coordinate measuring machines (CMM) take fast, accurate measurements. Advances in computer controls and new machine designs are increasing their use on automated assembly line inspection.

Dimensional measurements are static physical descriptions of distances, angles, areas, and volumes. During manufacturing, workers take many dimensional measurements. These are compared to dimensions prescribed in drawings or tables of specifications. The maximum allowable difference between the measurement and the specified size is known as a tolerance. Tolerance is the range of measurements acceptable for the part, usually stated as plus or minus a distance from the specified size. (Example: .625"+/-.005" means the acceptable size is .620" and the largest is .630").

Dynamics measurements gage moving objects or forces. Fluid pressures of oils and compressed air are checked, as well as volumes of material moving on a conveyor or out a spray gun's nozzle. Speeds and rpms measurements help control the motions of machines as materials are moved or processed in manufacturing.

Precision refers to how close to true size a measuring device or operator measures.

Accuracy refers to the repeatability of the measuring device and/or operator to continually get the same reading for the same measurement. Accurate measuring is a skill developed with practice using quality instruments.

A key term used when considering a measuring tool is discrimination. This is the finest unit of measure the tool or scale being used is capable of taking. Steel fractional inch rules have scales of 4 discriminations including 1/8", 1/16", 1/32", and 1/64". Vernier bevel protractors have a discrimination of 5' (1/12 of a degree), vernier calipers and standard micrometers 0.001", and vernier micrometers 0.0001". When comparing measuring tools, increases in either accuracy or discrimination boost the costs of the instruments.

Learning Check Sheet: Meas.001

Answer the following:

1. Define measurement.

2. List five physical things which are measured.

   A.
   B.
   C.
   D.
   E.

3. In what three ways are measurements used in manufacturing?

   A.
   B.
   C.

4. List three reasons precision-made parts are more expensive to produce.

   A.
   B.
   C.

5. Measurements are a form of what?

6. Name two devices with which semiprecision measurements are made.

   A.
   B.

7. Most of the world uses what measuring system?

8. List four types of dimensional measurements.

   A.
   B.
   C.
   D.

9. What term is used for the acceptable difference between a specified dimension and an actual measurement?

10. Define accuracy.

11. What do increases in discrimination do to the costs of measuring tools? Why?

Learning Check Sheet Answer Key: Meas.001

1. Measurement is determining the actual size, degree, or amount of something in units of a measurement system.

2. A. Dimensions
   B. Weight
   C. Speed
   D. Pressures
   E. Volumes

3. A. Describe
   B. Construct
   C. Control

4. A. More expensive measuring tools are used.
   B. More expensive machines to produce parts.
   C. More time to machine and measure.

5. Communication

6. Choose two of the following: steel rules, any heads of combination square, measuring tapes, transfer instruments, or any semiprecision tool.

7. SI Metric System

8. Distance, volume, area, angular

9. Tolerance

10. Accuracy is the repeatability of a measuring tool or operator to continually get the same reading for the same measurement.

11. Increase the costs of measuring tools. Tools must be made with more precision which takes more time, expensive machining tools, and costly measuring tools.

Student Activity Sheet: Meas.001

DIRECTIONS: Divide into groups of 3-5 persons, discuss, agree upon, and write down group answers to the following. Be prepared to give answers to the class.

1. List examples of how manufacturers use measurements to describe, construct, control. Give three examples for each area.

2. Teacher assigns your group one machine in lab. Sketch it. Label parts built only with semiprecision measurements. Label parts made with precision measurements.

3. Given this problem, identify and explain two possible causes.

   PROBLEM: Your company makes small parts with manually controlled mills and lathes. Measurements are taken during machining. At final inspection, occasional parts are found to be the wrong sizes. All machines are in excellent condition with no control problems.

4. A manufacturer has to decide whether to build products which are metric or customary. Your team has to decide which measuring system to use. After picking one, list five reasons or advantages for your team's choice.

5. Your company builds precision aircraft controls. Is it more important to buy measuring tools with high degrees of accuracy or discrimination? Why?

Alternative Learning Strategies: Meas.001

Teacher assigns groups of 3-5 students a list of review measuring activities. Rather than a routine review, teacher could challenge teams with a reward for the first group to finish. The lists students are given should ask questions about tools or measurements to find in shop.

It is recommended that the teacher make out a worksheet for his/her own shop. Here are some suggested questions:

1. What is an acute angle? How many tools in the shop will measure one?
2. How many square inches is the doorway to the shop?
3. Describe two ways to check a precision square for squareness.
4. What is the smallest radius on any one of our shop radius gauges?
5. Within +/-1/64", what are the measurements of a new standard pencil?
6. List all the metric linear measuring tools you find.
7. How many types of fluid pressure gauges are in the school or shop?
8. What is your weight in kilograms?

Learning/Performance Checks: Meas.001

The instructor evaluates student learning based on answers to learning check sheet and answers to group problem-solving activity.

With regard to performance check, the instructor should consider student's contributions to problem-solving activity. Student should be observed for interest and commitment to develop group solutions. Interpersonal action in group activity should be stressed as an aim of the group activity.

ACTIVITY NUMBER: MEAS.002

USES OF MEASUREMENTS IN MANUFACTURING

Description:

Groups of students develop class presentations illustrating the use of measurements in areas of manufacturing. These areas are Research & Development (R&D), Engineering, Materials Purchasing/Inventory Control, Production, Quality Control (QC), and Packaging/ Shipping.

Rationale:

Measuring abilities are required in most areas of manufacturing. They are not just used in layout, machining, and inspecting.

Outcomes:

Upon completion of this activity, student will be able to:

1. List and describe how six departments of a manufacturing firm use measurements.

Tools, Materials, Machines, and Resources:

1. Measurement (Video Series for individual development of measuring and layout in the machine shop). (1978-1986). Shawnee Mission, KS: RMI Media.
2. Tools & Rules for Precision Measuring (Video). (1981). Athol, MS: L. S. Starrett Co.
3. Magazine articles and technical product brochures depicting how various departments use measurements.

Instructional Strategy:

Students read information sheet defining areas of manufacturing. Instructor supplements information sheet with lecture/discussion. Students complete learning check sheet. Instructor divides class into groups of 3-5 students and assigns group a manufacturing area. Group researches area, develops outline, and makes 5- to 10-minute class presentation.

Safe Practices:

Instructor should require students to include safe measuring practices into group presentations.

Integrative Skills

Communication:

__x_ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Student Information Sheet Number: Meas.002

Measurements are used in almost every department of manufacturing. This information sheet briefly describes typical roles of these departments in manufacturing firms. With departmental roles defined, students participate in group activity to determine the uses of measurements within departments.

Research and Development

New products, as well as new production processes and methods, come out of research and development (R&D) departments. Not all companies have R&D departments. Companies with R&D departments have a distinct advantage of staying ahead of competitors.

R&D work includes pure research, applied research, and product design. Research can be either purely scientific experiments aimed toward discovery or applied research which uses scientific principles to solve manufacturing problems.

Development takes ideas discovered in research and utilizes them to improve or create products and processes. Most development is experimental, preliminary design-type work.

Engineering

After R&D has developed a desirable product or process, the engineering department works out the details to manufacture the product. The product design is finalized for best production. Detailed drawings, lists of specifications, and bills of materials are developed to guide the production and assembly.

Engineering tests products for safety, quality, service, and actual working performance. This information is used to improve product and processes.

Materials Purchasing/Inventory Control

Materials Purchasing orders and inspects raw materials, stock, and subcomponents from outside suppliers. Ordering the needed materials is critical to keeping production going. Purchasing personnel must determine the quantity and quality of future material needs.

Inventory Control stores purchased materials for delivery to the proper department at the right time. In some companies, this includes inventory of produced parts. Parts must be identified and warehoused for future use.

Production

Production uses machines and personnel to process materials. The number of processes depends on the complexity of the part. In machining, the first process is usually layout. Machines must be set up for tooling. Jigs and fixtures are made to hold and align parts during machining. Material sizes are checked before, during, and after machining.

Inspection/Quality Control

Inspection examines parts and materials at various points in production. Examining involves measuring and testing. This is often thought of as a post-machining step, but the role of Quality Control starts when materials enter the plant and follows products into actual service.

Packaging/Shipping

After the production processes, the product has to get to the customer. Packaging/Shipping's job is to protect and deliver the product to the wholesaler or customer. The right products have to get to the right places at the right time.

Learning Check Sheet: Meas.002

Write out 3- to 5-sentence answers discussing the following questions:

1. Why are measurements necessary in the Research and Development department?

2. In the Engineering department, how would measurements be used to improve product safety, quality, service, and actual working performance?

3. Why would Materials Purchasing/Inventory Control personnel need to measure?

4. Why are measurements taken during construction considered to be the most important ones?

5. Tell why Quality Control measurements duplicate other measurements.

6. Describe how measurements in Packaging/Shipping are different from other departments.

Student Activity Sheet: Meas.002

Directions: Read the information sheet and have the instructor clarify any questions regarding the roles of the different departments. The instructor divides students into groups of 3-5 students. Instructor will assign each group a department. Groups will develop a group presentation on measurements used in their department. The amount of available time for research will be determined by the instructor. Sources for topic presentation will depend on availability, but may include textbooks, workbooks, technical brochures, lab equipment, videos, transparencies, etc. Presentations should last 5-10 minutes and include a neatly made outline. Groups should answer the following questions in their presentations:

1. What measurements are used in their areas? Give 3-5 examples.
2. When are measurements taken?
3. Where are measurements taken?
4. How are the measurements used?
5. Why are these measurements needed?

Alternative Strategies Activity: Meas.002

After reading the information sheet, students are divided into groups of 3-5 students. The instructor supplies a part or print to each group.

Groups list each manufacturing department in order on a sheet. For each department, groups list probable measurements and measuring tools used on that part. Instructor can use different parts to add breadth to the assignment or have all groups use one part and discuss their findings in a summary.

Learning Performance Checks: Meas.002

Instructor evaluates student learning based on responses to learning check sheet and group presentation. Instructor should assess group presentation on thoroughness, clarity, and answering the assigned questions.

Performance as member of group is evaluated. Contributions and willingness to take on responsibilities are key elements in group participation. The amount of research indicates level of performance.

ACTIVITY NUMBER: MEAS.003

DYNAMIC MEASUREMENTS

Description:

Students identify dynamic measurements and devices used to measure them. Then find examples in their lab, take measurements, and interpret readings.

Rationale:

Measuring in manufacturing is widespread, going beyond dimensional measuring. Workers often measure other things including speeds, pressures, flows, and electricity.

Outcomes:

Upon completion of this activity, student will be able to:

1. Identify dynamic measurements found in shop.
2. List and measure three types of speeds.
3. Measure and calculate volume rate.
4. List basic electrical measurements.

Tools, Materials, Machines, and Resources:

1. Observation and measurement (Apple software for improving observation and measurement skills).
2. Any dynamic measuring tools found in shop.
3. Watch and measuring tapes.
4. Fluid volume measuring container.

Safe Practices:

Fluid pressures, speeds, moving volumes, and so forth are taken with machines turned on. Avoid moving parts, obey all safety rules, and get instructor's permission before measuring anything.

Instructional Strategy:

Teacher uses lecture, discussion, or videos to foster student awareness of dynamic measurements. Focus is on what is being measured, what gages or meters are used, and reading interpretation. Teams of students compete to see which group can identify the most measured dynamics in their shop.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

__x__ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
_____ Evaluation
_____ Implementation

Dynamic measurements are those which measure matter in motion or forces. Although the term "dynamic" indicates motions, some measurements discussed will be pressures. Measured things discussed in this information sheet include speeds, fluid pressures, electricity, and material flows. Measuring motions or pressures are usually done for control and/or safety reasons. Pneumatic or hydraulic systems need minimum and maximum pressure levels to work efficiently and safely.

Speeds are critical, since too slow costs time and too fast causes rapid wear or breakage. Cutting tools work best at certain speeds, depending on the material. Conveyor belt speeds need to be adjusted to coincide with the machine speeds.

There are linear, rotational, and cyclical speeds. Linear speeds move straight past a given point, such as parts on a conveyor belt or a forklift carrying a pallet. Rotational speeds are given in the number of revolutions per minute (RPM). Measured rotations mostly include spindle speeds on machines. Cyclical speed is how long it takes to complete an operation. This could mean how many parts are produced per hour or how long it takes a robot arm to pick and place one part. A cycle depends on what the observer wants to find out.

Example 1. Cyclical Speed

A plastic injection molding machine makes a milk crate every 45 seconds.

1. How many does it make per minute?

   Solution: 60 divided by 45 = 1.25 per minute

2. How many does it make per hour?

   Solution: 1.25 x 60 = 75 crates per hour

Most linear and rotational speeds are set using gears, belts, or pressure regulators. Final speeds are determined by what works best. If speeds are slow enough for the eye to see, they can be found using a watch and a measured distance. Cyclical speeds only need the watch. The speed is calculated simple by timing how long it takes for something to move so far. The formula for speed is distance traveled over time.

Example 2. Linear Speed

A conveyor belt on an assembly line is 75' long. It takes a part 3 minutes to move from one end to another.

1. How many feet per minute does it move?

   Solution: 75' divided by 3 = 25' per minute

2. In an eight-hour day, how far will the belt have traveled?

   Solution: 25' x 60 minutes = 1500' per hour

   500' x 8 hours = 12,000' per shift

A measurement related to speed is the volume rate, which is how much moves past a given point over a period of time. Materials moving on conveyors, through pipes, out of spray nozzles all are moving volume. The gallons on the gas station pump record volume, but not rate because time is not a factor. A flow meter on a TIG or MIG torch indicates volume rate. If no meter is available, flow can be measured with a container and watch. This only works for fluids or granular substances. Make sure the container is large enough for the expected flow, and run the material into the container for a certain period, such as 30 seconds, 1 minute or 10 minutes. Use shorter periods of time and multiply to find flow rates for longer periods of time.

Example 3. Flow Rate

Determine the flow rate for a large spray finishing station in gallons per hour. The flow is measured for 10 minutes (1/6 of an hour) and is found to be 1.5 quarts.

Solution: 1.5 quarts x 6 = 9 quarts or 2.25 gallons per hour

Electrical meters have the widest spread use of any meter, mostly as test equipment. Volts, ohms, milliamps are monitored or checked with volt-ohm-meter (VOM). Amperages larger than 1-5 amperes are too great to be checked with a VOM; for these, an ampere gauge is required. Workers use meters to test components and electrical circuits.

There are many styles of VOMs, which all make the same electrical measurements. Some are analog (dial) meters; others are digital meters. VOMs have positive "hot" and negative "neutral" leads which plug into jacks. Many configurations of jacks are used. Before using any VOMs, make sure leads are plugged into proper jacks. If not, damaged meters or blown fuses may occur. Check with operations manual or instructor. Another rule to avoid damaging meters is to start with highest range and work to lowest.

Learning Check Sheet: Meas.003

Complete the following:

1. Fluid systems need minimum and maximum ____________________ to work properly.

2. Name one tool on which you will find a flow meter.

3. List the three types of motions.

   A.
   B.
   C.

4. What type of meter has a dial on its face?

5. Give two ways rotational motions are set.

   A.
   B.

Solve the following:

6. How many bolts per hour are made by a machine which completes one every 12 seconds?

7. A lathe coolant system is checked for flow. It is found to put out a quart every 40 seconds. What is the flow in gallons per hour?

8. Each crankshaft weighs 8.5 pounds. An assembly line makes 4 engines per minute. The assembly line is 100 feet long and moves at 10 feet per minute. How many pounds of crankshafts are on the conveyor at one time?

Learning Check Answer Key: Meas.003

1. Pressure

2. MIG or TIG welder

3. A. Rotational
   B. Linear
   C. Cyclical

4. Analog

5. Gears, Pressure regulators, Belts

6. 60 seconds divided by 12 seconds = 5 bolts per minute
   60 minutes x 5 = 300 bolts per hour

7. 60 minutes = 3600 seconds
   3600 sec. divided by 40 = 900 gallons per hour

8. Step 1. Find needed weight per minute of assembly.

   4 cranks x 8.5 pounds = 34 pounds of cranks per minute

   Step 2. Find total run time from one end of conveyor to other.

   100 ft. conveyor divided by 10 ft. per minute = 10 minutes run time from one to the other.

   Step 3. Multiply pounds of cranks per minute times minutes run time of conveyor.

   34 pounds x 10 minutes run time = 340 pounds on conveyor

Student Activity Sheet: Meas.003

Part One:

In your teams or groups, list every dynamic measurement found in the shop. For each measurement, the following should be answered:

1. What force or moving thing is being measured?

2. In what units are the measurements being made?

3. For which of the following reasons is this measurement being taken?

    a. safety
    b. check
    c. control

Part Two:

Perform the following activities. Record your results.

1. From a faucet or valve in the shop, find the flow rate of water in gallons per hour.

2. Time a student walking from a work station to the tool crib or storage room. If this student repeatedly made that trip getting just one tool each time, how many tools could he/she get in 30 minutes?

3. Put a machine on the slowest possible speed. Turn it on and count the revolutions in 30 seconds. How many rpms does the spindle turn?

4. Time one tool change for all basic types machines in the shop (lathe, mill, drill press, etc.). With each machine averaging 3 tool changes per hour, how many minutes per 8-hour day are spent changing tools for each type of machine? How minutes per hour for all machines?

Part Three (Optional):

Make the following measurements with a VOM:

1. Receptacle voltage.
2. Ohms through a resistor.
3. Transformer reduced AC voltage.
4. Low voltage DC.

Measure the following with an ammeter:

1. Current going to small electrical appliance (TV, drill, etc.).
2. Current going to a motor on a large machine.

Alternative Strategies Activity: Meas.003

Teacher saves old technical and trade magazines. After reading information sheet, students find three examples of each dynamic type measurement. For each type of measurement, students describe what is being measured. Identify the type of measuring instrument used. Tell if measurement is taken for control, monitoring, or safety reasons.

Learning Performance Checks: Meas.003

Instructor evaluates student learning based on responses to learning check sheet and team answers to activity sheet.

Instructor evaluates performance based on student's effort and contributions to group activity. Particular attention should be paid to the student's ability to complete activity without close supervision.

ACTIVITY NUMBER: MEAS.004

ERRORS IN MEASURING AND CORRECT PROCEDURES

Description:

Students write and produce video on measuring errors.

Rationale:

Incorrect measurements are not only of little value, they can often be costly. Workers need to detect them, find their cause, and remedy the situation. Increasingly companies are training their own workers. Videos such as this one are used to train workers.

Outcomes:

As a result of this activity students will be able to:

1. Identify and give examples of operator measuring errors and measuring instrument errors.
2. List three characteristics indicating measuring instrument quality.
3. List seven good measuring practices.
4. Write and film video on measuring errors and correct measuring procedures.

Tools, Materials, Machines, and Resources:

1. Automated manufacturing. (1987). Springfield, IL: Illinois State Board of Education. (Units 27-30)
2. Olivo, C. T. (1987). Machine tool technology and manufacturing processes. Albany, NY: C. Thomas Olivo Associates. (pp. 16-18 and Unit 4)
3. Measurement and Layout Tools (Apple software covering correct use of common measurement and layout instruments). (1987). Springfield, OH: Hearlihy and Co.
4. Measuring and Layout Tools (Apple software providing instruction on correct usage of common measuring tools). Springfield, OH: Hearlihy and Co.

5. Resources for researching measuring errors and correct methods: textbooks, manuals, overhead transparencies, etc.

6. Video camera, tape, VCR, and cassette recorder.

7. Use Meas.004/Fig. 1.

Instructional Strategy:

Introduce students to errors in measurement by reading information sheet, any additional readings, complete worksheets, and discuss topic. Students prepare to make video by researching and writing script. Instructor checks script and student taping plans prior to taping. During taping by a team, instructor keeps other teams busy away from taping.

Safe Practices:

Obey all shop safety rules on and off video.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
_____ Evaluation
_____ Implementation

General types of measurement errors occur in either the instruments or by the operator. Errors in measurement can be costly. It is just as important to prevent them as it is to detect incorrect sizes. In regard to measuring, the term "accuracy" means two things: one is how close to true size the tool measures; the other is how well the operator uses the tool. Accurate measuring means fewer and smaller errors.

Besides accuracy, two indicators of measuring instrument quality are discrimination and repeatability. Discrimination (also called precision) refers to the smallest graduation read on the instrument's scale. Repeatability is when an instrument consistently measures the same size.

Measuring tool errors have numerous causes. A tool might be made of inferior quality parts or poorly assembled. Instruments wear out from use or become damaged by misuse. Some tools may be fixed or calibrated, others must be replaced.

Many measuring instruments need periodic adjustments or recalibration. These need to be performed routinely and correctly to insure machine accuracy. An operator's manual lists the procedures to calibrate the tool. Calibration often requires the use of special tools or gauges.

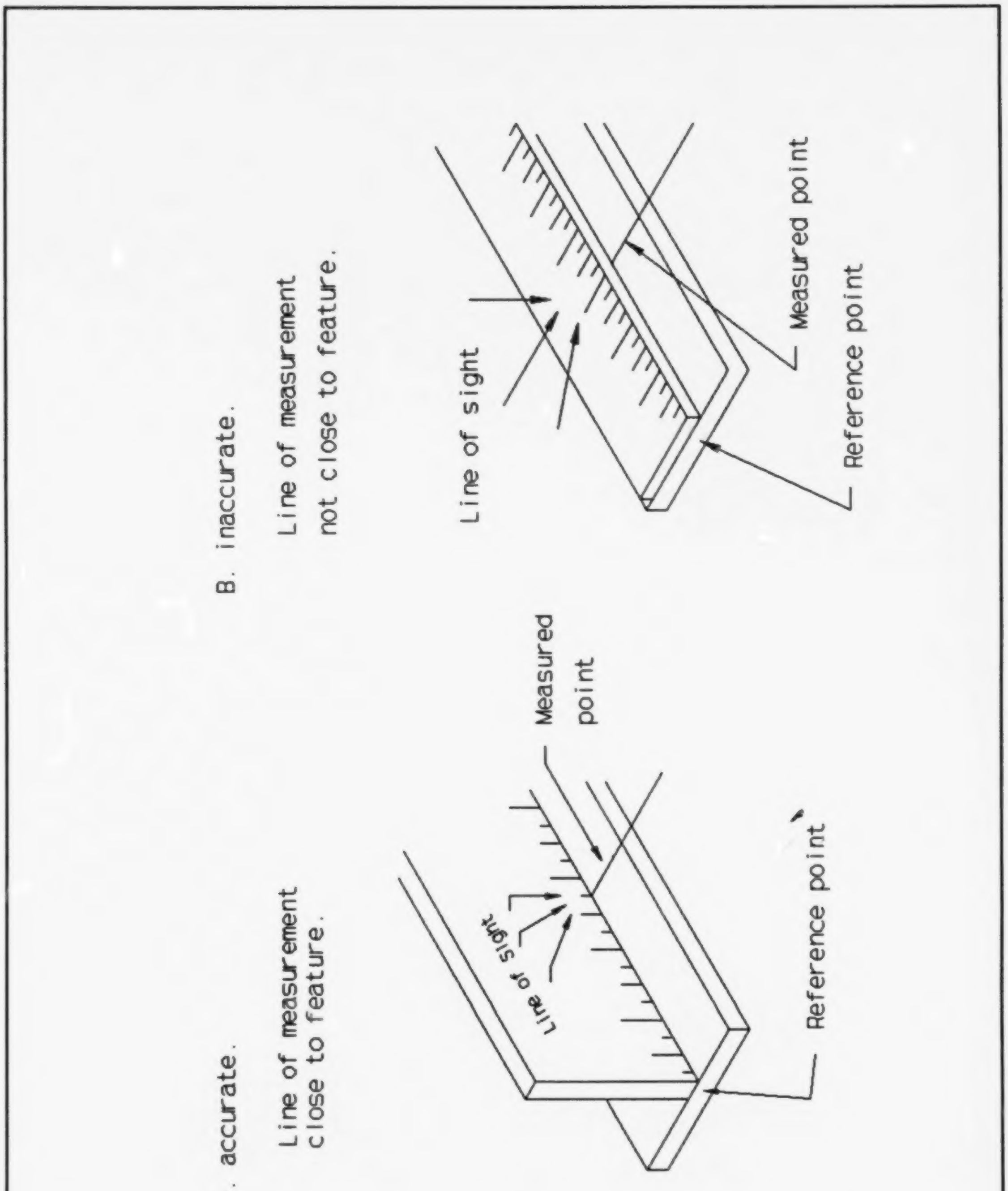
The measuring tool operator might make several kinds of errors. Possible errors depend on the type of machine. One of the most common is reading the graduations wrong. Correctly reading a ruler, vernier, or micrometer takes practice, good light and vision.

Another operator error is called "parallax," which results from an operator not lining up his/her line of sight with the measured point and graduation on the ruler (Fig. A1). Parallax may be minimized by keeping the ruler perpendicular to the measured surface.

Manipulative errors occur when operators mishandle either the measuring tool, work piece, or both. Hand-held tools should not be cramped, misaligned, or forced. Slippage can happen when the work piece is heavy, or the measuring tool may slip if held for a long time or in an awkward fashion.

Operator errors resulting from unconsciously misreading tools are worker-bias ones.

Occasionally dirt, oils, or burrs are on measured points. These can cause incorrect readings. Workers should inspect surface conditions prior to measuring.


A. accurate.
Line of measurement close to feature.
Line of sight
Measured point
Reference point
B. inaccurate.
Line of measurement not close to feature.
Line of sight
Measured point
Reference point

Meas.004/Fig. 1. Examples of Correct Ruler Alignment and Parallax Error (ERRORS IN MEASURING AND CORRECT PROCEDURES, Meas.004)

Some good measuring practices are:

- Develop a light touch with measuring tools. Use minimal pressure.
- Keep eye (line of sight) in line with measuring tool and measured point.
- Hold tool in proper alignment.
- Keep surfaces clean and free of burrs.
- Inspect tools prior to measuring, and check accuracy.
- Recheck all measurements.
- Record measurements; avoid reliance on memory.

Learning Check Sheet: Meas.004

Complete the following:

1. What are the two general types of measuring errors?

   A.
   B.

2. Prior to measuring, list three things surfaces should be checked for?

   A.
   B.
   C.

3. Why should measurements be recorded?

4. How much pressure should be used when measuring?

5. What is discrimination?

6. What is repeatability?

7. What is the error called when line of sight, measuring tool, and measured point are misaligned?

8. What is worker-bias error?

Learning Check Answer Key: Meas.004

1. Operator and instrument
2. Burrs, oil, dirt
3. Avoid memory errors
4. Minimum "light touch"
5. Discrimination is the smallest unit of graduation on a measuring tool.
6. Repeatability is the ability of a measuring tool to consistently measure same part same size.
7. Parallax
8. Worker bias error is unconsciously misreading the scale on a measuring tool.

Student Activity Sheet: Meas.004

Directions: Your class researches, writes, and makes a 10- to 20-minute video on types of measuring errors. The video should include detecting errors, identifying error, determining causes, giving solutions, and developing a list of measuring procedures. Use the following basic steps in making the video.

Step 1. Topics will be assigned. Your instructor will assign topics for your team to research and write a script on. One team could be assigned the job of filming. Topics could include the following:

A. Errors in reading a ruler

B. Errors in reading micrometers

C. Errors in reading vernier calipers

D. List of standard measuring procedures which will minimize measuring errors

E. Correct storage and handling of measuring tools

Step 2. Research topic. Your team researches a topic using textbooks, manuals, audiovisuals, instructional aids, etc. The extent of the research will depend on the time allotted by the instructor. Each topic should fill 2-5 minutes of video. Teams must take notes and record sources of information during research. Instructor will check on groups of students periodically during research to help answer questions, give guidance, and keep students on task.

Step 3. Write script. The first step in script writing is to prepare an outline for instructor approval. The outline should list material to be covered, demonstrations to be taped, and informational scenes. After approval of outline, students write scripts. Scripts should be one or two pages long, including narration and description of camera shots. Script are read into tape recorder for timing and clarity. Instructor approves final script and decides on order for taping.

Step 4. Preparation for taping. Use all materials for practice taping. Concentration should be given to demonstrations and camera movements.

Step 5. First taping. Topic segments are taped in logical sequence. After a preview of tape, the class will critique segments and make suggestions for form improvements.

Step 6. Final taping.

Alternative Strategies Activity: Meas.004

Directions: Students are given a list of measuring problems. For each problem, students answer the following questions:

1. What is the most likely error?
2. List two or more possible causes.
3. For each cause give a solution.
4. Could preventive checks have prevented this error? If so, what exactly?
5. Would better worker training prevent this error? If so, what exactly?

The instructor should provide a list of measuring problems most appropriate to the students' lab activities. Some suggested example problems follow:

1. It is found that all shaft diameters between 2" and 3" are 0.010" over size.
2. A worker is found to always lay out angles 1 degree too small.
3. Stock coming from the cut-off saw ranged from 1/8" too large to 1/16" too small.

Learning Performance Checks: Meas.004

Instructor evaluates student learning by checking responses to learning check sheet and written script. Observing students demonstrating measuring errors and proper measuring techniques indicates application abilities. The quality and quantity of research demonstrate level of student gain from the activity.

Performance checks are taken when instructor observes students participating in group activity. Initiative and effort in the taping are key elements for assessment.

ACTIVITY NUMBER: MEAS.005

COSTS IN MEASURING

Description:

Students make and measure various parts and assess the measuring costs involved, including labor, measuring equipment, and shop time.

Rationale:

Measuring is a necessary, yet manageable cost. In a competitive market, costs need to be monitored to avoid waste. Workers must meet essential measuring requirements with minimal costs.

Outcomes:

Upon completion of this activity, student will be able to:

1. List three costs related to measuring.
2. Define and calculate fixed measuring costs.
3. Identify and calculate shop time measuring costs.
4. List five rules for cost efficient measuring.

Tools, Materials, Machines, and Resources:

1. Standard shop measuring tools.
2. Machine tools in shop.
3. Finished parts for measuring and materials to be machined during measuring activity.

Instructional Strategy:

Students learn about basic costs in measuring through reading, worksheet, and discussion. Parts are laid out, then machined with measuring costs being calculated. Next, the measuring costs which went into finished parts are estimated.

Safe Practices:

Shut off machines and avoid sharp edges during measuring.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

______ Assertiveness
______ Negotiation
______ Listening
______ Risk Taking

Change:

______ Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications________________________________

Decision Making:

______ Ethical Reasoning
___x___ Logical Reasoning
______ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
______ Implementation

Measuring takes shop time, tools, and labor, which all cost money. It is a necessary task. The costs of measurements vary, depending on such things as degree of precision, measuring tools, and amount of time.

The fixed costs of measuring tools depend on the quantity and quality. Higher quality greatly increases the costs of measuring tools. It is a waste of money to pay for higher quality than the measurements require.

Tool costs are fixed by what measuring tools are "on-hand" in the shop. Exact tool costs per measurement are difficult to determine, especially for small tools where it is hard to track the hours of usage. Not all tools wear out at the same rate. A simplified way to determine measuring tool costs is take the total value of all shop measuring tools, divide by the average tool lifetime in work days. This gives the fixed daily cost of all measuring tools.

Example for fixed daily costs:

A shop has a $25,000 inventory in measuring tools which average a life of 10 years. There are around 250 work days in a year.

Step 1. 10 years times 250 days = 2,500 day life span.

Step 2. $25,000 divided by 2,500 = $10.00 tool cost per day.

Shop time measuring costs are related to whichever machine is being operated. Measuring time on a mill is more expensive than measuring time on the layout table. The hourly costs of a mill (including labor) could be $75.00, while the hourly costs of a layout table could be $25.00. An inspector might cost $15.00 per hour.

Calculating shop time costs for measuring a given part is simple. Decide at which operations measurements will be taken and determine the measuring costs for each operation. The costs of each operation are totaled.

These steps are used to figure the measuring costs for each operation. First, record time in minutes. Next, convert the minutes to tenths of an hour by dividing by 6. Change the tenths of hours to hours by moving the decimal one place to left. Then, multiply the hours of measuring by the hourly rate. Machine rates include the operator costs, so labor is only calculated for jobs such as manual inspection.

Example for calculating total measuring costs:

Operation 1: Layout

Figure the layout costs of a pump housing which will be milled. The layout took 72 minutes. Layout table rate is $25.00 per hour.

Step 1. 72 minutes divided by 6 = 12 tenths or 1.2 hours.

Step 2. 1.2 hours times $25.00 = $37.50 layout costs.

Operation 2: Milling

During the milling of a pump housing, 18 minutes were spent measuring. What is the milling measuring cost per pump housing? The milling machine operates at $75.00 per hour.

Step 1. 18 min. divided by 6 = 3 tenths or .3 hours.

Step 2. .3 times $75.00 = $22.50 measuring costs while milling.

Operation 3: Inspection

After this pump housing is milled, it takes an inspector 30 minutes to inspect it. The inspector cost is $15.00 per hour. Find the inspection measuring costs.

Step 1. 30 min. divided by 6 = 5 tenths or .5 hours.

Step 2. .5 times $15.00 = $7.50.

Calculating Total:

Find the total production measuring costs of the pump housing. Add all inspection costs.

Layout costs	$37.50
Measuring during machining	$22.50
Inspection	$ 7.50
Total measuring costs (not including fixed tool costs)	$67.50

To avoid wasting costly time, only necessary measurements should be taken. Some rules to follow to avoid unnecessary measurements are:

- Identify and plan measurements to be taken prior to starting.
- Measure only dimensions specified on print.
- When machining, use feed dials to track size of cuts rather than continual measuring.
- Use fastest tool available that has the precision desired.
- Measure in a logical, progressive order.

Learning Check Sheet: Meas.005

Solve the following:

1. What is the daily fixed measuring tool cost in a shop with $12,000 worth of tools which will last seven years?

2. What is the daily fixed measuring tool cost in a shop with $75,000 worth of tools which have an average life span of 10 years?

3. How much should a company expect to spend yearly on measuring tool replacements if their inventory is $50,000 and the average life span is 10 years?

4. What is the inventory value of measuring tools in a company with a daily tool cost of $40.00 and tools which last an average of 6 years?

For problems 5-7, the following costs per hour are given:

Surface grinder	$35.00
Mill	$65.00
Lathe	$60.00
Drill press	$25.00
Layout table	$20.00
Inspection	$15.00

5. What is the total measuring cost for a transaxle housing which took the following measuring times?

Layout	24 minutes
Mill	6 minutes
Inspection	12 minutes

6. What is the total measuring cost for a hammer which took the following times?

Layout	12 minutes
Lathe	3 minutes
Drill press	3 minutes
Inspection	3 minutes

7. What is the total measuring cost for a mill arbor which took the following times?

Layout	54 minutes
Mill	6 minutes
Lathe	24 minutes
Grinder	12 minutes
Inspection	6 minutes

Learning Check Answer Key: Meas.005

1. $6.85

2. $30.00

3. $20.00

4. $60,000.00

5.	Layout	$8.00
	Mill	$6.50
	Inspection	$3.00
	total	$17.50
6.	Layout	$4.00
	Lathe	$6.00
	Drill press	$2.50
	Inspection	$1.50
	total	$14.00
7.	Layout	$16.00
	Mill	$6.50
	Lathe	$24.00
	Surface Grinder	$7.00
	Inspection	$1.50
	total	$55.00

Student Activity Sheet: Meas.005

Directions: In this activity, teams assigned by your instructor will determine the measuring costs for a part on which they produce and estimate measuring costs for a given part. Group jobs which should be assigned are timer/recorder, measurer, machine operator.

Part One: Record and calculate measuring costs for a given part made from a print.

Step 1. Groups identify operations from print where measurements will be taken.

Step 2. Groups perform operations required to make part, keeping a record of time spent measuring.

Step 3. Calculate total cost of measuring based on hourly machine rates supplied by instructor.

Part Two: Estimate and calculate measuring costs for a given part.

Step 1. Group identifies operations on part where measurements would have been taken.

Step 2. Group estimates time spent measuring on each operation.

Step 3. Calculate total cost of measuring based on hourly machine rates supplied by instructor.

Alternative Strategies Activity: Meas.005

Directions: In this activity, groups will determine the total replacement costs of measuring tools in shop. Each group lists measuring instruments found in the shop. Instructor provides tool catalogs for students to find prices. Prices are totaled for shop. Life average of all tools is given by instructor, or use 10 years. A school year has 180 days. Calculate average daily fixed measuring expense.

Learning Performance Checks: Meas.005

Instructor evaluates student learning based on completed Learning Check Sheet and written responses to activity problems.

Student performance in activity is evaluated based upon team's completion of recording measuring times and calculating measurement costs. Individual students are observed for competency in calculating measuring costs.

ACTIVITY NUMBER: MEAS.006

COORDINATED MEASURING

Description:

A simulation of a coordinate measuring machine (CMM).

Rationale:

CMMs are increasingly being used in industry. They are accurate, fast, and can be computerized. There is a growing link between computerized CMM and statistical product control (SPC) and to CAD/CAM. Workers should be familiar with the operation of CMMs and equipment.

Objective:

Upon completion of this activity, the student will be able to:

1. Describe the operation and basic parts of a CMM.
2. List five advantages of CMM over conventional measuring.
3. Describe a 3-axes linear coordinate system.
4. Set up a simulated 2-axes linear coordinate system; make and record measurements.
5. Discuss the link between CMM and SPC and CAD/CAM.

Tools, Materials, Machines, and Resources:

1. Coordinated Measuring Machine Series (a group or self-paced instructional program of four video tapes and an application guide). (1989). Cleveland: Technicomp.
2. CMMs are growing in use and articles abound in trade journals.
3. Felt tip marker, graph paper.
4. Flat surface such as a surface plate or mill table.
5. Use Meas.006/Fig. 2 and Meas.006/Fig. 3.

Instructional Strategy:

Teacher introduces students to CMM with reading, discussion, and/or video. Student learning is checked with written and oral questions. Teams of students construct a CMM simulator and compare it to conventional surface plate measuring.

Safe Practices:

General shop safety precautions should be mentioned and reinforced prior to constructing CMM simulator.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications____________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Coordinated measuring machines (CMM) measure on a 3-axes (3D) grid system. The machine plots measured points using the X, Y, Z grid coordinates (Meas.006/Fig. 2). CMMs use a computer to compare plotted points with specified dimensional points and determine if measured features are within tolerance. The features of part are inspected for size, location, shape and distance from other features. CMMs replace surface plates and all the related measuring instruments.

CMM's primary components (Meas.006/Fig. 3) are:

1. Staging table where parts are secured during measuring.
2. Measuring superstructure which travels over the staging table. The movements of the measuring superstructure are along the three coordinate measuring axes.
3. The probe is the end piece which locates the measured points.
4. Computer and software where measurements are calculated, stored, recalled for printouts, and used to recreate drawings of measured parts.

The CMM works by moving the probe along the three axes to find coordinates for measured points. The three axes meet at a zero point, going in positive or negative directions until reaching maximum measuring range, the "envelope" of the machine. The "Z" axis moves up (positive) and down (negative). The "Y" axis moves back (positive) and front (negative). The "X" axis moves left (negative) and right (positive). Cartesian or linear coordinate system is the term for the three axes measuring system. Points are determined by measuring distances moved along the axes.

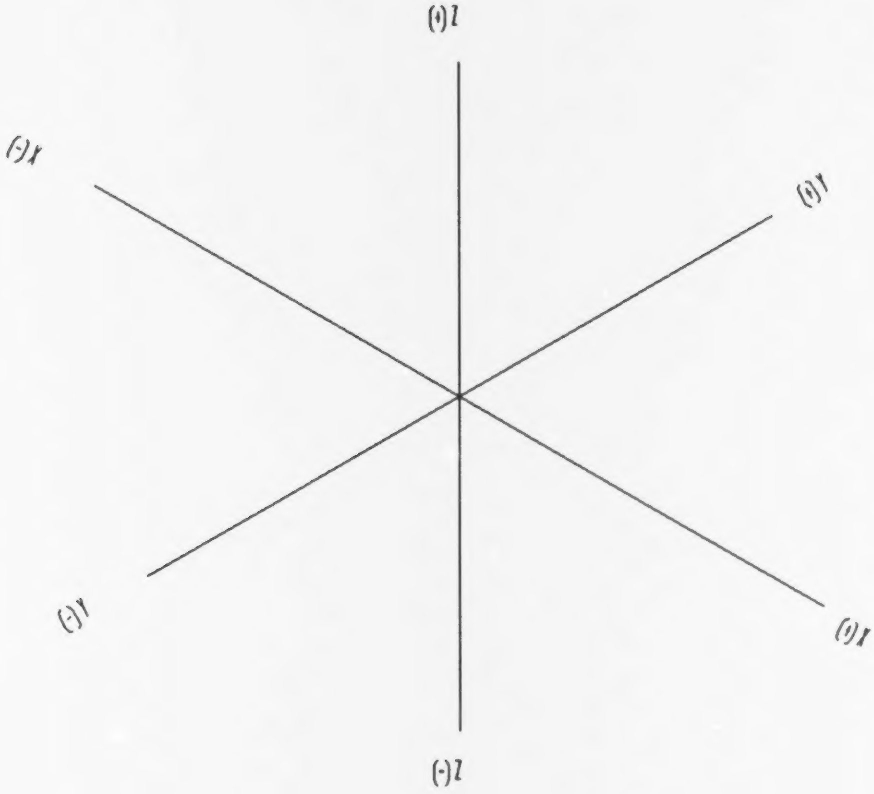
CMMs may also use a polar coordinate system for locating points. The steps to locate a feature by the polar system are:

Step 1. Determine point zero, called the U value, a starting point assigned the value of zero.

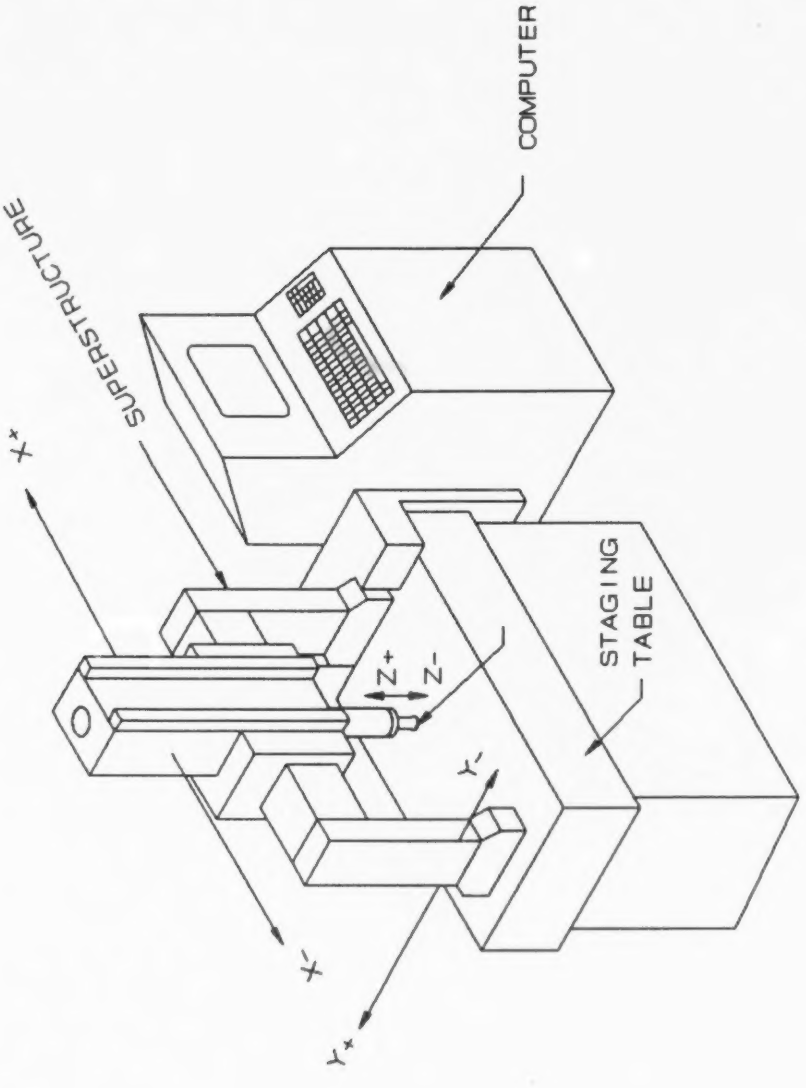
Step 2. Locate the reference line.

Step 3. Determine the polar angle. This is the angle from the reference line to the line upon which the point is located.

Step 4. Use the polar radius to locate the point along the polar angle.



Meas.006/Fig. 2. CMM Axes


COMPUTER
SUPERSTRUCTURE
X+
X-
Z+
Z-
STAGING TABLE
Y-
Y+

Meas.006/Fig. 3. Typical CMM with Primary Components Labeled

There are numerous advantages of CMMs over the conventional surface plate and measuring instruments. One of these is alignment, which is aligning zero points and reference lines of the part and the measuring equipment. In conventional measuring, alignment is a slow manual process. CMMs use computers to make mathematical compensations for part and instrument misalignment. Less time is wasted during part setup.

Other advantages of CMMs are:

- Measures faster, with more accuracy and less human error.
- Measures almost any part in one step.
- Measures consistently.
- Can work with numerically controlled machine tools, adjusting the machine based on fluctuations in finished parts.
- Provides a record of part quality and compliance with specifications.
- Furnishes data for SPC and computer-aided design and manufacturing (CADAM).

Some of the newest advances in CMMs are coming to SPC. Quality has become such a priority that companies are willing to invest in expensive CMMs, which greatly increase the speed, consistency, and the ability to inspect using statistical sampling.

The advantage of CMMs in CADAM is the ability to work backwards. The CMM can measure a part and develop a drawing from the measurements. Prototypes and engineered parts can be made to fit, then measured by a CMM. These measurements can be used for CNC programming and CAD drawings.

Two key problems with CMMs are that operators need high skill levels and the costs of equipment are high. Workers, who know conventional precision measuring techniques and have the ability to read prints, can be trained to operate CMMs.

Equipment costs for CMMs vary greatly with the precision, accuracy, and repeatability. Many first-time buyers do not know enough about CMMs to purchase the right machine for their needs. Some get too little quality for their measuring needs, others spend much more than needed. Typically, there are uninformed buyer problems when purchasing any emerging technology.

Student Activity Sheet: Meas.006

Directions: In this activity, your team will build a CMM simulator and measure parts with it. There are other ways to simulate a CMM. One is given here, but you are encouraged to look for the one most appropriate to your setting.

One way to simulate a CMM is to use a mill. A preferred mill is one with digital readouts of bed movements. Many readouts are only two axes, whereas CMMs are 3 axes, but the concept of measuring distances moved along axes is the same. For mills without digital readouts, the micrometer dials on longitudinal and crossfeed hand wheels will work.

The first part of the CMM to simulate is the probe. Probes are very sensitive instruments which open and close an electrical circuit as contact is made with the part. The probe is easy to simulate using a continuity tester probe. The continuity probe is kept insulated, put in a chuck which is put in the spindle. The tester ground is attached to the mill table. When the measured point on the part contacts the continuity probe, current will flow. A simpler, but less accurate way to simulate the probe is to insert a felt tip marker into a chuck.

The mill bed simulates both the staging table and the tracking axes of the superstructure. A part held in the mill's vise will be moved into contact with the continuity tester probe. The longitudinal movement on the bed is the Y axis; the crossfeed, the X axis.

Simulation of the computer takes place in the student's mind when controlling the machines movement's, recording, and interpreting results.

This simulation primarily measures features parallel or perpendicular to the two axes of movement. Curves and diameters could be measured, but would take unnecessary calculations beyond the scope of this simple simulation.

A special reminder is that many mill bed lead screws are worn. If your handwheel has any play in it, start about two turns out from the work and run into the work. If you back up any during inward movement, back out beyond the free play and start over. Otherwise, micrometer dial readings will be off.

An alternative to using a solid part for measuring would be to use a sketch or drawing attached to the mill. Use the felt marker probe to measure outline or features of a part.

Measuring with the CMM simulator is very straightforward. Measurements made in this simulation will be close. They are not intended to be accurate, since this simulation intends to familiarize students with coordinate measuring machine concepts.

Step 1. Set up continuity tester for probe.

Step 2. Mount the piece to measure in the vise.

Step 3. Decide on a zero point; then run part up against it until current flows.

NOTE: Continuity probe is rigid and easily bent so use very delicate touch.

Step 4. Set micrometer dials to zero.

Step 5. Back off probe (Do NOT drag along work!). Then move to new location.

Step 6. Read micrometer dial, record as positive or negative X, Y movements.

Step 7. Use graph paper to record coordinate movements, label zero point and X-Y directions, scale squares, and sketch in points measured on X-Y coordinates.

Learning Check Sheet: Meas.006

Complete the following:

1. In what directions do the following axes move on a CMM?

   X axis=___________ and ___________
   Y axis=___________ and ___________
   Z axis=___________ and ___________

2. What two skills must an worker have prior to learning how to operate a CMM?

   A.
   B.

3. What is another term for a linear 3-axes coordinate measuring system?

4. The staging table of the CMM replaces what traditional measuring part?

5. Besides linear coordinates, what system can a CMM use to locate points?

Answer and explain the following:

6. Why do first-time buyers often spend too little or too much money on CMMs?

7. CMMs store records of sizes of finished parts. List and explain three uses for these records.

   A.
   B.
   C.

8. CMMs allow an engineer to work backwards, taking a part which works and making a detailed drawing. How would this save design time?

Learning Check Answer Key: Meas.006

1. X axis = left and right
   Y axis = front and back
   Z axis = up and down

2. Print reading and use conventional precision measuring techniques

3. Cartesian coordinate system

4. Surface plate

5. Polar system

Alternative Strategies Activity: Meas.006

A 2-axes or 3-axes coordinate measuring system can easily be simulated on graph paper. To do this, the following are needed:

- Graph paper
- Steel rule and combination square
- Part and print of part

To simulate, follow these steps:

1. Set part on graph paper and align with graph lines.
2. Examine drawing and determine zero point.
3. Find points on part feature to be located.
4. Measure points using 2-axes or 3-axes coordinates. Decide which axes are X and Y.
    - Ruler must be kept aligned with graph paper lines which are the linear axes.
    - Use the graph lines which intersect at the zero point as reference lines.
    - Measure positive or negative distances from reference lines.
    - If making a Z-axis measurement, the base of the piece is zero, making all measurements positive.
5. Determine dimensional distances on drawing for points measured in Step #4. This requires calculating drawing dimensions of all points from the zero point and reference line.
6. Compare measured distances to feature points with dimensional sizes.

Learning Performance Checks: Meas.006

Instructor will evaluate Learning Check Sheet and written responses in activity for student learning.

Student performance will be evaluated based on team participation in the setup, measuring, recording, and comparison of measurements to dimensions.

ACTIVITY NUMBER: MEAS.007

VISION MEASURING SYSTEMS

Description:

Students are introduced to fundamental concepts of vision measuring. Using a video camera, students simulate a vision measuring system.

Rationale:

As technologies evolve, vision measuring instruments probably have the most potential for automated measuring and inspection.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Identify and describe the major components of a vision measuring system.
2. List five uses for a vision system.
3. Give the four ways vision controllers process image data.
4. Describe the operation of a photoelectric cell (pixel).
5. Explain the increasing role of vision systems in manufacturing.
6. Simulate the operation of a vision measurement system using a video camera.

Tools, Materials, Machines, and Resources:

1. Automated manufacturing. (1987). Springfield, IL: Illinois State Board of Education, 1987. (Unit 178)
2. Zuech, N. (1987). Gaging With vision systems. Dearborn, MI: Society of Manufacturing Engineers.
3. Machine vision (video gives basic introduction to machine vision systems, their operation and uses). (1986). Dearborn, MI: Society of Manufacturing Engineers.
4. Pencil, paper, graph paper, and felt tip marker.

5. Low shadow light source.

6. Use Meas.007/Fig. 4.

Instructional Strategy:

The instructor introduces the concepts of operation and components of vision measuring through lecture, handouts, or video presentation. Student learning of fundamental concepts is checked through written or oral examination. Instructor discusses and demonstrates steps for vision measuring simulation activity. Groups of students are given parts which they measure with vision system.

Safe Practices:

During simulation, obey all shop safety rules.

Integrative Skills

Communication:

[✓ Reading]
[✓ Writing]
_____ Speaking
[✓ Listening]

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
[✓ Negotiation]
[✓ Listening]
[✓ Risk Taking]

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
[✓ Logical Reasoning]
_____ Flexibility

Problem Analysis:

[✓ Identification]
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet: Meas.007

Vision systems are finding an increasing role in automated manufacturing. These systems serve many functions such as measuring, identification, sorting, inspection, control or guidance, and alignment. Vision measuring is primarily for inspection purposes.

Every vision system is built around two basic elements, a sensor or "eye" and processor or "brain." In the human vision system, our eye gathers raw data about the size, shape, position, color, texture, and so forth. This raw information has no meaning until sent to the brain for processing. The brain interprets the information by comparing it to internally stored data,"memory," or accessing a resource such as a chart or book. Finally, the brain evaluates the processed data and makes a decision. The decision could be to accept, reject, rework, sort, move part, or control movement.

An eye will pick up much more information than a brain can process at one time. A brain must be programmed to look at the particular information for necessary decision making. Programming involves learning what information to gather and how to make decisions. In manual measuring, the human eye gathers information by reading a micrometer, a print dimension, and a tolerance block. The brain has access to huge amounts of information, but logic helps it search in the most likely place first. It searches through information on micrometers, not steel rules. For organization and efficiency, decisions are made logically.

Machine vision systems also have two parts: a photosensitive device (the eye) and a vision processor (the brain). These systems are primarily used in automated work cells. In 1987, around 700 vision systems were being used in the U.S. By 1992, it is estimated that 50,000 vision systems will be in operation. These systems perform the following tasks:

- Part identification
- Part location
- Part orientation
- Part inspection
- Range finding

A block diagram (Meas.007/Fig. 4) of a typical vision system is shown below. It consists of one or more cameras, some type of camera controller, interface equipment between camera and the working equipment, and some type of cathode ray tube (CRT) or image display. The camera is used to obtain an image of the piece or process. This image is then transferred to the image processing and analysis equipment, where information is extracted, compared with stored information, and decisions made regarding the outputs to work cell or automated equipment.

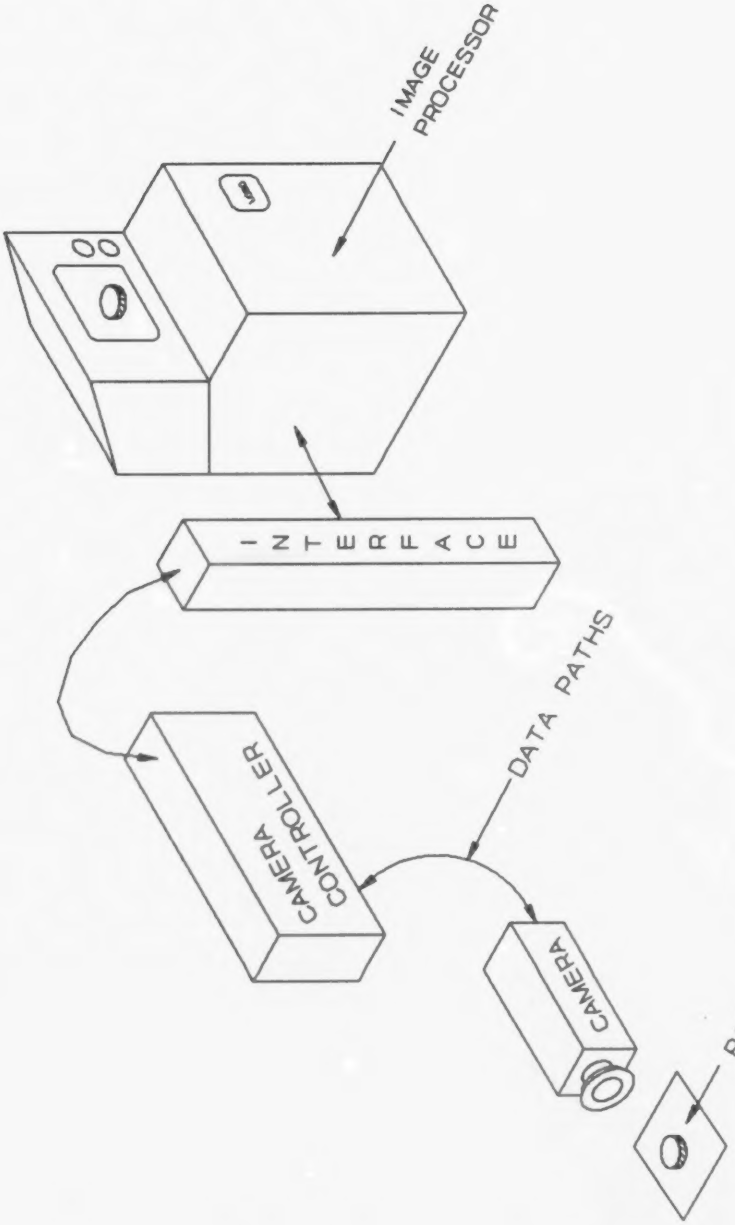


IMAGE PROCESSOR
INTERFACE
DATA PATHS
CAMERA CONTROLLER
CAMERA
PART

Meas.007/Fig. 4. Diagram of a Typical Vision System
(VISION MEASURING SYSTEMS, Meas.007)

A source of light is the first thing needed in obtaining an image for processing. Proper lighting is the most important aspect of an effective measuring system. The light source may be positioned in front of or in back of the object, depending on the particular application. The system can only be as good as the lighting utilized.

Image processing starts with a video camera taking a picture. A video camera contains hundreds of photoelectric cells (pixels), arranged in a rectangular matrix called a photosensor. When the camera takes a picture, each cell in the photosensor reacts to light from a small portion of the image. Each cell produces a slight electrical charge; the greater the light, the greater the voltage. These voltages transform into levels from dark to light. The total of all electrical charges is the video image to be processed.

Some of the ways a controller can process a video image are:

- Pixel counting
- Connecting analysis
- Gray-scale analysis
- Training and recognition

The vision processor takes input from the camera and analyzes information from each pixel. One way to process information is to count foreground and background pixels. This is a binary process where pixels above a specified light level are foreground and those below are background. An example of this would be to put an object on a piece of graph paper, then count every square touched by the object. For measuring, this method is only accurate to within one pixel.

Connectivity analysis is the most general purpose image processing method. It is a binary method like pixel counting. The processor links adjacent foreground pixels to form line segments or "blob" images, which are features of the part. The processor examines the length, width, area, and gray level of up to 50 blob images, comparing them with stored information.

Gray-scale analysis processes pixels according to their light level, usually 0 to 63. Adjacent pixels within a specified range are linked together to form shapes which are statistically analyzed. With its high degree of discrimination, gray-scale analysis is currently the most precise vision-measuring process.

Training and Recognition software utilizes connectivity analysis to recognize objects in the camera's view. This process has two stages. In the first stage, called training, a sample part is put in front of the camera to place an image in memory. The second stage compares subsequent parts to the sample.

Vision measuring can be done with any of the four methods mentioned above. The most common method has been pixel counting, but advances in cameras and processing equipment are increasing the use of gray-scale measuring. Rather than binary "on/off" counting, gray-scale analysis can differentiate between amounts an object sticks into a pixel. The level of gray is a measure of how far an object goes across a pixel. Current vision technology in use by industry measures accurately and reliably within 0.002".

Learning Check Sheet: Meas.007

Complete the following:

1. How close can present vision measuring systems measure within?

2. What is the most important aspect of a vision system?

3. List five things a vision system might do.

   A.
   B.
   C.
   D.
   E.

4. List four ways controllers could process vision image data.

   A.
   B.
   C.
   D.

5. An increase in light hitting a photoelectric cell will increase what?

6. What are the two major components of a vision system?

   A.
   B.

7. Describe the first stage in Training and Recognition.

8. List four decisions a vision processor might make from a vision image.

   A.
   B.
   C.
   D.

9. What vision processing method is only accurate to within one pixel?

10. What are two parts of programming?

Learning Check Sheet Answer Key: Meas.007

1. 0.002"

2. Light source

3. A. Part identification
   B. Part location
   C. Part measurement
   D. Part orientation
   E. Range finding

4. A. Pixel counting
   B. Gray-scale analysis
   C. Connecting analysis
   D. Training and Recognition

5. Voltage

6. Photosensitive eye (camera), vision image processor (controller)

7. Take picture of sample part

8. A. Accept or reject
   B. Rework
   C. Sort
   D. Move part or control movement

9. Pixel counting

10. Learning and decision making

Student Activity Sheet: Meas.007

This is a simulation activity lacking computer image processing. The image processor is simulated with your mind. The photosensor is simulated by placing a part over graph paper. Each square on the paper represents one pixel. You will simulate both pixel counting and gray-scale image processing. In this activity, students will complete a vision measuring simulation following these steps:

Step 1. Obtain part from your instructor. Part should be thin, almost two dimensional.

Step 2. Set up video camera. It may look at the part vertically or horizontally, whatever works best for your setup.

Step 3. Place piece of graph paper on other side of where part will be located.

Step 4. Put part into position, align with graph lines and illuminate it. Use video image for counting graph squares.

For pixel counting analysis:

Step 5. Find length, width, and area of part by counting all pixels which part covers totally or partially.

For gray-scale analysis:

Step 5. Find length, width, and area of part by assigning a scale from 0 to 10 for each pixel. End pixels will only be partially covered by the part. This partial covering is assigned a value from 1 for 10% covered, to 2 for 20% covered, and so on up to 10 for 100% covered. This assigned percentage determines the amount of the pixel counted in the measurement.

Example: Use 0.250" (1/4") square graph paper. The width of a part covers(totally or partially) 12 squares. The first square is 50% covered and the twelfth square is 20% covered. Find the width.

Solution: 10 totally covered squares = 2.500"
first square covered 50% = 0.125"
twelfth square covered 20% = 0.050"
total 2.675"

Step 6. (For both pixel and gray-scale analysis), compare vision measurings with measurements taken with precision measuring tools.

- How close were the pixel counting measurements?

- How close are the gray-scale counting measurements?

Alternative Learning Strategies: Meas.007

Vision measuring can be simulated with graph paper and a part. The part is placed upon the graph paper and squares are counted just as vision processor counts pixels. Lines on paper and reference lines on part must be aligned. Gray-scale may be simulated by estimating percentage of part covering graph square.

Vision inspection could be simulated with the outline of a part on a transparency. This transparency is laid over a part and compared to a part. This simulates a camera taking a visual image of a part and the controller comparing the picture taken to reference data.

Learning/Performance Checks: Meas.007

Teacher evaluates learning performance based on answers to learning check sheet, and contributions during class discussions.

Student performance is evaluated based on team participation setting up, making vision measurements, and comparing measurements.

ACTIVITY NUMBER MEAS.008

DECIDING ON METRIC OR STANDARD MEASURING

Description:

Students serve on team deciding which products should be made using metric standards or customary standards.

Rationale:

As the United States continues to become more involved in the global marketplace, goods shipped overseas must be made with metric standards for acceptance and salability. Products sold nationally usually are built with customary measurements for the same reasons. Which system of measurement to use is something decision makers must determine.

Outcomes:

Upon completion of this activity, students will be able to:

1. Identify the two major measuring systems.
2. Give two advantages and one disadvantage of each system.
3. List five factors influencing which system to use.
4. Convert measurements from metric to customary and vice versa.
5. Given a list of products, teams of students will decide whether one measuring system would be preferred over the other for manufacturing the product.

Tools, Materials, Machines, and Resources:

1. Olivo, C. T. (1987). Machine tool technology and manufacturing processes. Albany, NY: C. Thomas Olivo Associates. (pp. 12-14)
2. Siggun, A. (Ed.). (1982). The metric system: A review of industrial applications. Dearborn, MI: Society of Manufacturing Engineers.
3. Let's Measure: Using Metric (Video Series). (1977). Deerfield, IL: Coronet/MTI Film & Video.
4. List of products or assemblies.

Instructional Strategy:

Instructor introduces topic with open discussion on conversion to metric system, then guides discussion into structured lecture comparing two systems, bringing out advantages and disadvantage of each. An audiovisual on measuring systems would help clarify the topic. Students complete learning check sheet. This helps the instructor to identify any students with misunderstandings prior to group activity.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Student Information Sheet Number: Meas.008

Measurement is a universal language. In order to standardize this language, measurement systems have evolved. These systems are crucial to part interchangeability around the world. Because of measurement systems, one inch or one meter are the same sizes anywhere.

The two most common measuring systems are the metric and customary. The customary is used mostly in North America, while the rest of the world uses metric. Following the world's lead, America is slowing converting to metric measurements.

Each system has advantages, although the metric system has more. One advantage of the customary system is its use in the largest single industrial country, the United States. This means that products made with customary measurements are more likely to be purchased here, especially replacement parts. Fractional customary measurements conveniently get smaller or larger, usually by powers of 2, going from 1/2" to 1/64" or 1/2 gallon to 1 cup, whereas metric units change by powers of 10, such as going from kilometers to millimeters.

Because of powers of 10, the metric system works well for computational purposes. Formulas work better; there are no fractions to change or convert, only decimal points to move around. Units like cubic centimeters transform directly to cubic meters much faster than cubic inches transform into cubic yards.

During this evolution to the metric system, American manufacturers increasingly must decide what measurement system to use. For each product, there are many factors to consider. Some of these are:

1. Where will the product be sold (North America, Europe, Africa)?

2. Who will use the product (people, places, businesses)?

3. What measurements are being used to make similar products? Consumers are likely to purchase products similar to those which exist.

4. What measurements are used on component parts going into the final assembly? Subassemblies could be metric or standard.

5. What measurement system is the plant currently using to measure and manufacture?

Decisions on which system to use should be based on answers to the above questions and any others specific to a product or manufacturer. Manufacturing committees answer questions like these when deciding which measuring system to use.

The basic equivalent units for each system follow:

Equivalent Customary and Metric Units of Measure

Customary to Metric

Measured Property	Customary Units	Metric Equivalent
lengths	1 yard (yd)	0.9114m or 91.14cm
	1 foot (ft)	0.3048m or 30.48cm
	1 inch (")	2.54cm or 25.4mm
areas	1 square inch	6.452 sq. cm
	1 square foot	0.0942 sq. m
volumes	1 cubic inch	16.393 cu. cm
	1 cubic foot	28.3171
	1 gallon (gal.)	3.7851
mass	1 pound (lbs.)	0.454kg
speed	1 foot per second	0.3048 meters/sec.
	1 mile per hour (mph)	1.609kph
fluid pressures	1 pounds per sq. in. (psi)	0.0703kg/sq. cm

Metric to Customary

Measured Property	Metric Units	Customary Units
lengths	1 millimeter(mm)	0.0394"
	1 centimeter(cm)	0.3937"
	1 meter(m)	39.37"
areas	1 sq. cm	0.155 sq. in.
	1 sq. m	1549.9 sq. in=10.76 sq. ft.
volumes	1 cubic cm	0.061 cu. in.
	1 liter (l)	61.023 cu. in.
mass	1 kilogram (kg)	2.2046 lbs.
speed	1 meter per second	3.28 ft/sec.
	1 kilometer per hour	0.621 mile/hour
fluid pressures	1 kg/sq. cm	14.19psi

Quite often, workers have no choice over the measuring system used. Workers must convert units from one system to another. A conversion equivalency table is used. The units are converted from one system to another by multiplying the total number of units by the equivalency factor for one unit.

Examples:

1. How many millimeters long is 3.758"?

   Solution: 3.758" times 25.4 = 95.45mm

2. How many cubic inches are there in 5.5 liters?

   Solution: 5.5 liters times 61.023 = 335.62 cu. in.

Learning Check Sheet: Meas.008

Answer the following:

1. What are used to standardize measuring languages?

2. What is the most common measuring system in the world?

3. A product made in Canada is most likely to be built with what measuring system?

4. What are two advantages of the customary system?

   A.
   B.

5. What are two advantages of the metric system?

   A.
   B.

6. List five factors influencing the decision for which measuring system to use.

   A.
   B.
   C.
   D.
   E.

7. How many centimeters long is 11 inches?

8. How many inches long is 0.46mm?

9. How many grams equals 3.5 pounds?

10. How many kg/sq. cm equals 140 psi?

Learning Check Sheet Answer Key: Meas.008

1. Measurement Systems

2. SI Metric System

3. Customary or inch-pound system

4. Used in the U.S. and divides units into easy-to-work-with fractions

5. Used in 90% of the world and units easy for calculating

6. A. Where will product be sold?
   B. Who will use the product?
   C. What type of measuring system is used for similar products?
   D. What measuring system is being used on other components of assembly?
   E. What measuring system is the factory currently using?

7. 11" times 2.54 = 27.94cm

8. 0.46mm times 0.0394 = .018"

9. 3.5 pounds times 454 = 1,589 grams

10. 160 psi times 0.0703 = 11.25 kg/sq. cm

Student Activity Sheet: Meas.008

DIRECTIONS: The following are five products and information about the manufacturer of each. In small groups, decide which measuring system will be used in the manufacturing of the product. For each product, write down answers to the five general questions to consider, which are found on the information sheet for this activity. One measuring system may be preferred over the other or which system used might not matter.

Product #1. 10-speed touring bicycles

The manufacturer is a small New England firm with 30% of sales going overseas. Sprockets and wheels come from a European supplier.

Product #2. Industrial looms which produce fabric

These are made by a Cleveland company using 75% American parts. The firm exports around 2/3 of its looms.

Product #3. Inexpensive hydraulic automobile jacks

A Los Angeles manufacturer builds these using mostly imported parts. Jacks are sold nationally to discount houses and tool wholesalers.

Product #4. Business photo copiers

A Midwestern-based office machines company makes these copiers using about 50% foreign parts. Approximately 80% of these copiers stay in the US.

Product #5. Irrigation pumps and valves

This Georgia company manufactures irrigation supplies with few parts from outside firms, exporting 55% of what it produces.

Alternative Learning Strategies: Meas.008

A simple activity to help foster awareness in the two measuring systems is to check all the machine and power tools in the shop. Find which ones are made with metric measurements, and for each of those, have the class discuss the five information sheet questions as to why these tools were made with metric measures.

Learning/Performance Checks: Meas.008

Student learning is evaluated by score on learning check sheet and answers to group problem-solving activity.

Instructor evaluates group answers and performances of individuals. Answers are evaluated based on reasoning and development, not necessarily on answer selection.

ACTIVITY NUMBER MEAS.009

PRODUCTION MEASURING DECISIONS

Description:

In this activity, for a given assembly or detailed print, students make measuring decisions. Students fill in a flow chart, additionally noting when to measure, who measures, what tools to use, and the purpose of measurement.

Rationale:

Workers need to know more than just how to measure. Many decisions must be made regarding measurements. Decision-making ability develops with practice.

Outcomes:

Upon completion of this activity, students will be able to:

1. Identify who measures during production operations.
2. Note when measurements will be taken during production operations on parts.
3. Identify what measuring tools will be used for measuring.
4. Give the purpose for measurements taken on parts.

Tools, Materials, Machines, and Resources:

1. Wright, R. T. (1987). Processes of manufacturing. South Holland, IL: Goodheart-Willcox. (pp. 418-420).
2. Basic Dimensional Measurement Series (Video series and workbooks covering techniques for most kinds of dimensional measuring). (1986). Cleveland, OH: Technicomp Pub.
3. Flow chart form.

Instructional Strategy:

Instructor introduces activity with discussion on measuring decisions which answer the questions of what, when, where, why, and how. Lecture is reinforced with information sheet, learning check sheet, and any available audiovisual materials. Students complete flow chart for given drawing/part. Based on the flow chart, students answer assigned questions regarding measuring decisions. After answering questions, instructor leads a class correction, which aids student learning.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__ x __ Reading
__ x __ Writing
__ x __ Speaking
__ x __ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__ x __ Assertiveness
__ x __ Negotiation
__ x __ Listening
__ x __ Risk Taking

Change:

_____ Personal Adaption
__ x __ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
__ x __ Logical Reasoning
__ x __ Flexibility

Problem Analysis:

__ x __ Identification
__ x __ Solutions
__ x __ Evaluation
__ x __ Implementation

A worker's ability to operate measuring tools is of little value, unless one also has the capability to apply these skills. During the application of skills, many decisions are made. Many measuring decisions result from habits. Oftentimes, these habits evolved from trial-and-error experiences. Work habits are hard to break because they are accepted as routine and unquestioned. For this reason, many manufacturers hire outside consulting firms to come into a plant and evaluate shop practices, including measuring.

Measuring is not a stand-alone production operation; rather, it is part of other operations such as inventory, layout, machining, and final inspection. The purpose of the measurement depends on the operation.

One way to avoid habits learned from trial and error is to develop habits from logical procedures. Measuring decisions can follow a logical procedure. A method to accomplish this consists of listing production operations of a part, identifying when measurements should be taken, and answering the questions of who, what, how, and why. To an experienced worker, the answers to these questions are obvious; they have become routine. For inexperienced workers, these questions can be puzzling; they must learn a pattern for analyzing measuring.

The first question to answer is "who" will do the measuring. If raw materials are measured at the receiving dock, who does this task? It could be the dock worker, the receiving supervisor, or someone from the inspection department. In critical precision layouts, the layout worker measures as the work is being laid out, but usually the work is doubled-checked by someone else--a fellow worker, a supervisor, or an inspector.

During production, many personnel could measure. Setup workers measure as they adjust the machine and construct any jigs and fixtures. Machine operators measure stock before, during, and after machining. Someone is responsible for making necessary measurements.

"What" to measure is the next question. Does every measurement on the part have to be made or will one measurement do it? The answer to this question determines what will be done. Compliance with the print usually determines what to measure. Typically, inexperienced workers often measure the wrong thing or miss measurements.

"Where" on the part to measure is probably the easiest question to answer, if the worker can read prints. Sometimes inspection workers have to decide whether to do the measuring on the production floor or take the part to a central inspection station.

The basic skill of choosing and using the right measuring tools answers the question of "how" to measure. The purpose of the measuring answers the question "why" was the measurement taken. This is usually a function of the operation. If the operation is layout, that is the purpose.

Learning Check Sheet: Meas.009

Complete the following:

1. Worker ability to operate measuring tools is of little value unless what?

2. Why are work habits hard to break?

3. What are two ways workers learn measuring habits?

   A.
   B.

4. Describe one logical procedure for making measuring decisions.

5. List three possible types of personnel who might measure at the receiving dock.

   A.
   B.
   C.

6. Which production workers measure as they adjust machines and build jigs and fixtures?

7. What usually determines "what" will be measured?

8. Where are two possible plant locations an inspector might measure at?

   A.
   B.

9. Typically, inexperienced workers make what two measuring errors?

   A.
   B.

10. What answers the question "why" the measurement is taken?

Learning Check Answer Key: Meas.009

1. One has the capability to apply the measuring skills.

2. They are routine and unquestioned.

3. A. Trial and error.
   B. Developing logical procedures.

4. Listing production operations of a part, identifying when measurements should be taken, and answering the questions of who, what, how, and why.

5. A. Dock workers.
   B. Receiving supervisor.
   C. Inspectors.

6. Setup workers.

7. Compliance with the print.

8. A. The production floor.
   B. Central inspection station.

9. A. Measure the wrong thing.
   B. Miss necessary measurements.

10. The purpose or the function of the operation.

Student Activity Sheet: Meas.009

The purpose of this activity is to determine when to measure, with what tools, and the purpose of the measuring. Your instructor may have you work on this individually or in small groups. The team approach will speed up the activity and allow you to help each other.

The first step is to take an assembly drawing and make a flow chart covering all operations.

Identify all operations in which measurements will be taken. This answers the question of "when." In chronological order, list on another sheet each operation in which measurements are taken.

For each operation, answer the following questions:

Who measures?

What is measured?

How are the measurements being taken?

Why or what is the purpose of the measurement?

Your instructor should have you correct the answers to these questions in class, randomly selecting who will answer a question for each operation.

Alternative Learning Strategies: Meas.009

An activity for instilling a logical procedure for answering measurement questions entails showing a part, asking students questions in a logical order, and writing appropriate responses on board. This activity involves students and demonstrates a correct method to logically determine the measuring needs parts. To do this activity, the instructor should display or list all the shop's measuring tools. Show class simple parts. Students generate flow chart on board and identify measuring points. For each point, teacher calls on individual students to answer the questions of who, where, how, and why.

Learning/Performance Checks: Meas.009

Instructor evaluates student learning with responses to learning check sheet, answers to oral questions, and written answers in activity. Learning is displayed by students identifying measuring points and applying the procedure of answering the questions of who, what, how, and why.

Performance checks include teacher observation of student effort and skill demonstrated during activity. As activity evolves students should become quicker at identifying and clearer at answering questions if performance improves.

PRINT INTERPRETATION

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UNIT GOALS

1. Identify basic types of drawings and list purposes for each in manufacturing. (Print.001, .002, .005)
2. Identify and explain basic items in detailed drawings. (Print.001, .002, .004, .005)
3. Interpret notes and dimensions in order to make determinations for sizes, materials, and other part requirements. (Print.003, .004)
4. Interpret detailed drawing elements in regard to manufacturing processes to layout, plan, produce and inspect. (Print.001, .002, .003)
5. Based on detailed drawings, complete bill of materials, flow charts, and operations sheets. (Print.004, .005)
6. Discuss the future effects of electronic communications will have in linking departments and processes in manufacturing. (Print.001, .002)
7. Determine material requirements and estimate material costs from a print. (Print.004, .005)
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ACTIVITY NUMBER PRINT.001

TYPES OF DRAWINGS AND THEIR PURPOSES

Description:

Students review the purposes and types of drawings used in manufacturing. Students read an information sheet and complete a work sheet. Teams of students participate in exercise where they make written descriptions of given parts, then exchange descriptions with another team and draw part. Students compare graphic and verbal communicating of technical information.

Rationale:

Awareness of types of drawings and their purposes aids students in interpreting and selecting best type for desired communications. This activity stresses the importance of drawings in technical communications.

Outcomes:

Upon completion of this activity student will be able to:

1. List seven types of information that a print conveys.
2. Identify and list purposes for basic types of drawings.
3. Give four skills a worker with print reading ability possesses.
4. Distinguish between multiview, isometric, and oblique drawings.
5. Describe the purposes of auxiliary and section views.
6. Define schematic diagrams.
7. Contrast graphic and written communications.

Tools, Materials, Machines, and Resources:

1. French, T. E., et al. Mechanical drawing. (1985). New York: McGraw-Hill.
2. CAI Engineering Drawing-Working Drawings (Apple software). Hearlihy and Co. Pub.

3. Parts or undimensioned drawings of parts.

4. Use Print.001/Figures 1, 2, 3, 4, 5, and 6.

Instructional Strategy:

Teacher introduces fundamental uses of drawings in manufacturing through reading assignment/discussion and students complete worksheet on introductory materials. Class is divided into teams which are given parts. Each team measures part and writes out a verbal description of part. When completed, teams exchange verbal descriptions. Teams read verbal descriptions and draw out parts. Team drawings are then compared with actual parts. Teacher leads discussion where students compare graphic and verbal communications of technical information.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Student Information Sheet Number: Print.001

Except for word-of-mouth, drawings are the oldest form of communication. Pictures, like images, accurately convey information. The old saying "a picture is worth a thousand words" stresses this fact. The two major intentions of drawings are artistic and technical. Manufacturers use drawings for both reasons. Artistic uses include design and marketing. Technical applications include all phases of engineering and production.

"Print" is a term often used for detailed drawings. Drafters securely file original drawings after making prints, which are then used.

Interpreting technical drawings is often referred to as print reading. Technical drawings convey much more than a photograph can. Prints:

- Give true shape and sizes.
- Show external and internal details.
- Provide machining requirements.
- Provide assembly information.
- Reveal additional operations.
- Relate information on materials.
- Provide a record part and design personnel.

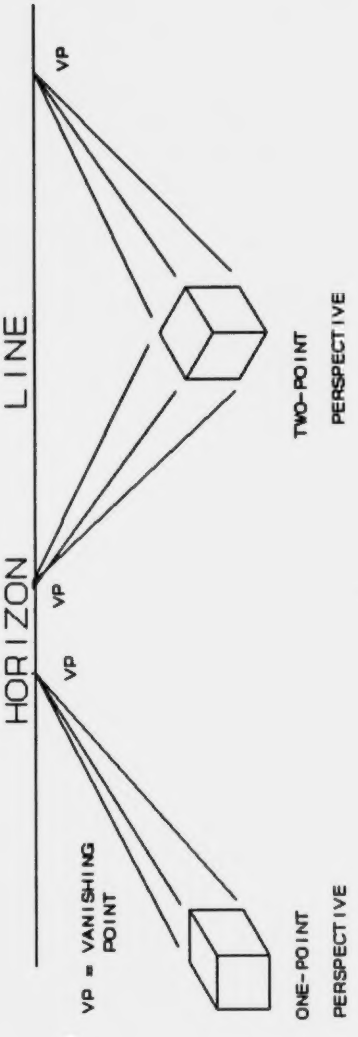
Manufacturing personnel develop their ability to read prints through study and first-hand experiences. The skill of print reading enables them to:

- Visualize a part.
- Envision production operations on parts or assemblies.
- Develop additional drawings.
- Make required measurements.

Graphic communication requires personnel to have an understanding of the basics of technical drawing. Comprehension of the basics includes:

- Classification of drawings and their purposes.
- Title blocks.
- The alphabet of lines.
- Notes and dimensioning.
- Sections and auxiliary views.
- Abbreviations and symbols for processes.
- Computer aided drafting.

There are two major classifications of technical drawings. One is perspective; the other is parallel. Perspective drawings show the image the way the eye or camera sees it (see Print.001/Fig. 1). Objects close to the viewer are proportionally larger, getting smaller as they recede toward vanishing points. Perspectives may have one, two, or three vanishing points. Perspective drawings have limited technical use because they do not illustrate an object's true shape. Perspectives


HORIZON LINE
VP
VP
VP
VP = VANISHING POINT
ONE-POINT PERSPECTIVE
TWO-POINT PERSPECTIVE

Print.001/Fig. 1. Examples of Perspective Drawings (PRINT INTERPRETATION, Print.001) have an aesthetic value, useful for demonstrating "eye appeal" of an object's design. Looks become important when considering alternative designs and consumer tastes.

Parallel drawings have no vanishing points. Lines projecting toward the view point are all parallel; they do not focus in on the point of view as do perspectives. This causes parallel projections to look slightly distorted to the eye, but it also reproduces a true shape image onto the plane of projection. It is this true image which permits designers/ engineers to make scale drawings which communicate accurate information.

There are several classifications of parallel projections. Each has a purpose. Examples of each of the three most used are given in Print.001/Fig. 2.

Multiview drawings have the advantage of being able to accurately represent a true shape and size of a part. Multiviews, supplemented with section and auxiliary views, can visually describe even the most complex objects. The major disadvantage of multiviews is that it takes training in print reading to correctly interpret them. True shape objects often appear somewhat like optical illusions.

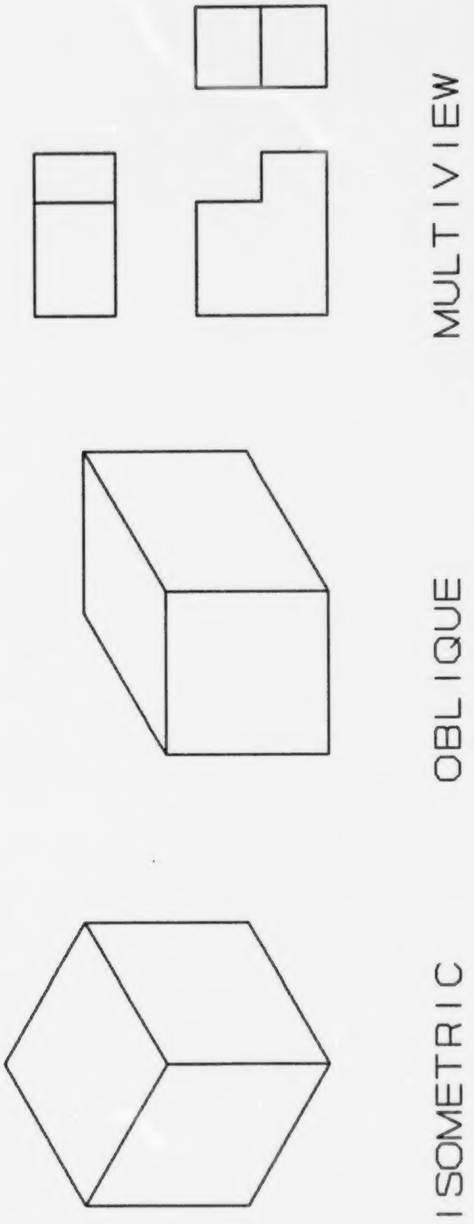
The technical term for multiview drawings is "orthographic projection," which project the true shapes of an objects onto parallel viewing planes. Exact images are cast because the lines emanating out from the object are parallel to one another and perpendicular to the viewing plane.

A first step in interpreting multiview drawings is learning the position of the views. There are several ways to position views. The only one discussed here is third-angle projection, because it the most widely used in North America.

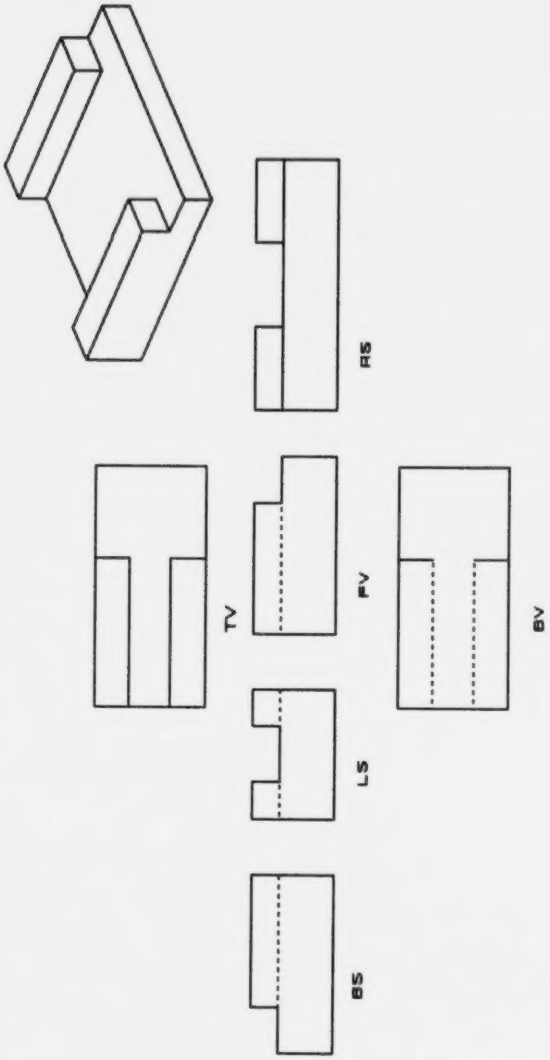
Multiviews have six basic views which are front, top, bottom, right side, left side, and back (Print.001/Fig. 3). A combination of these views accurately presents information needed to describe an object. Also, auxiliary and section views can be used to show additional features. The complexity of an object determines the number of views needed to describe it. Simple objects can be described in one view, others two; typically, three are used. Only needed views are shown (see Print.001/Fig. 4).

Only surfaces which are parallel to one of the viewing plane show up as true size in the basic views. These are called normal surfaces. Inclined and oblique surfaces need an extra view to show them as true shape. These are known as auxiliary views. An example is found in Print.001/Fig. 5.

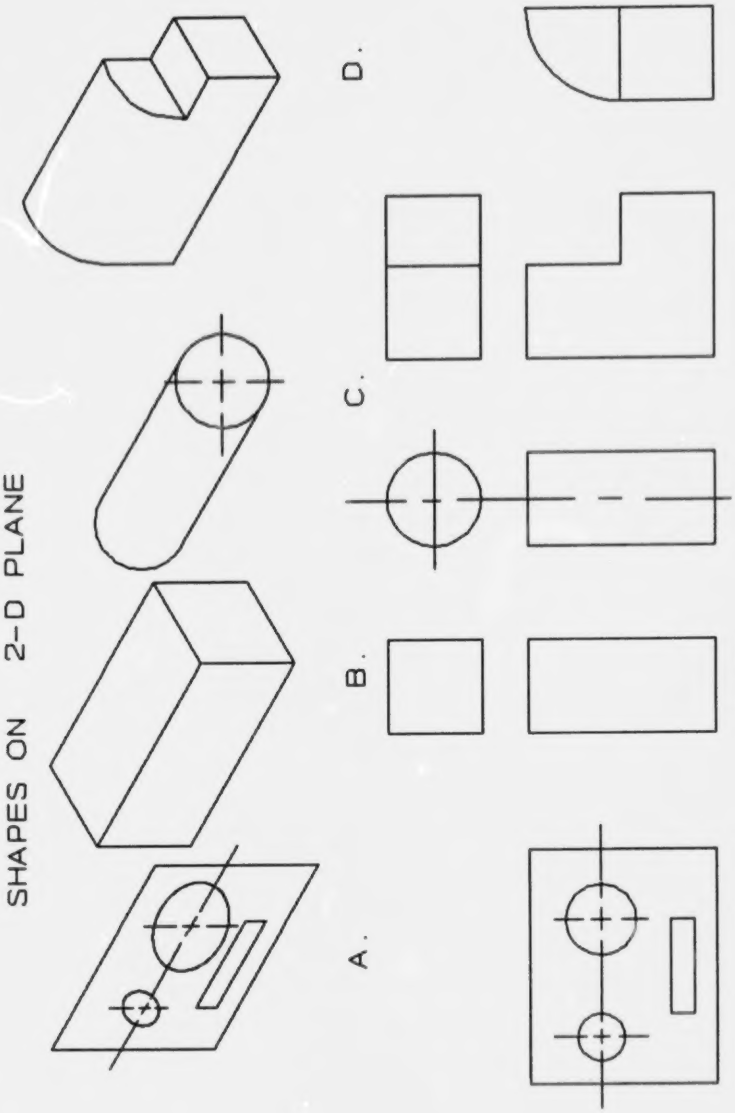
Complex internal features need section views to describe them. In section views, an imaginary portion of a part is cut away to depict interior details. The four most common types of section views are shown in Print.001/Fig. 6.


ISOMETRIC
OBLIQUE
MULTIVIEW

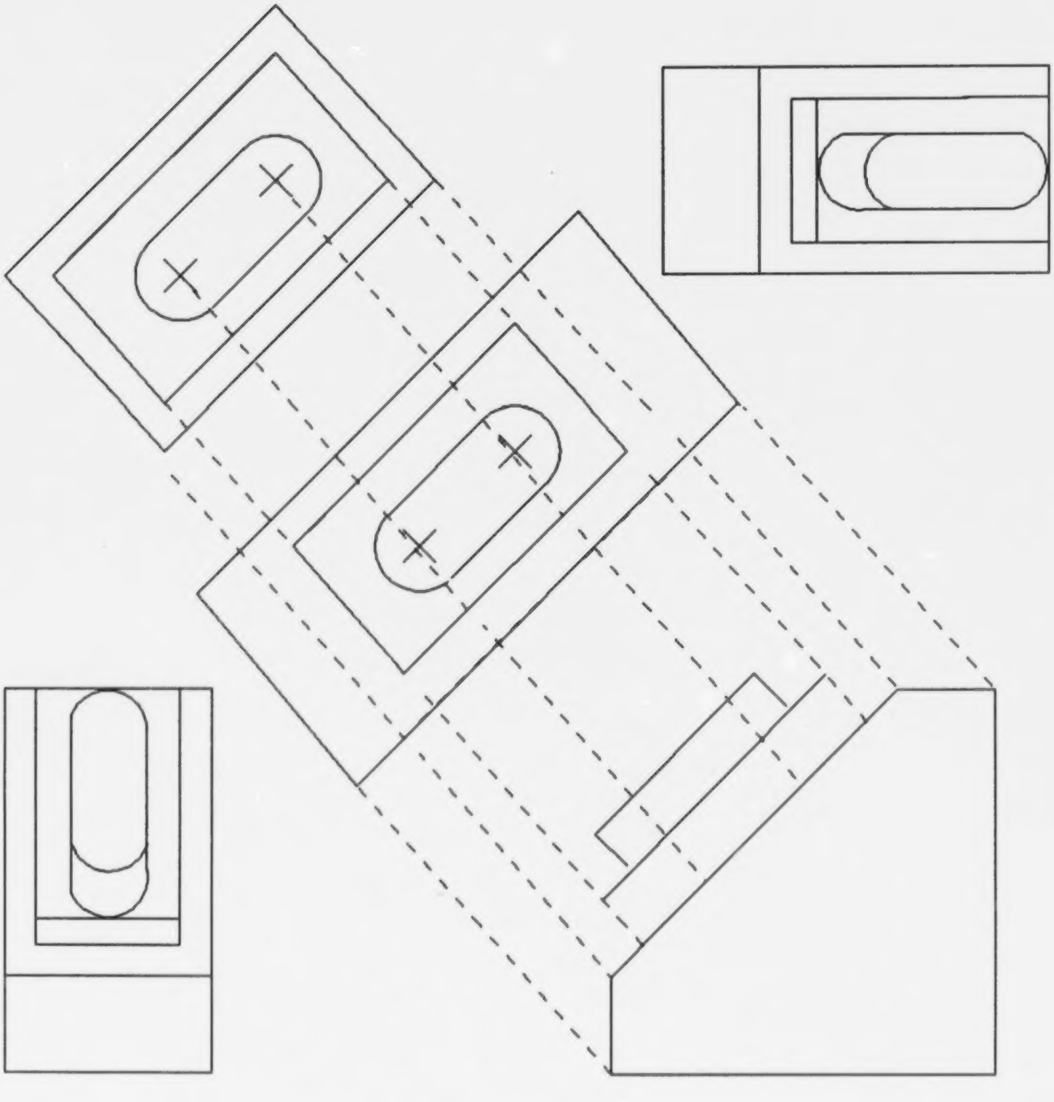
Print.001/Fig. 2. Examples of Parallel Projections (PRINT INTERPRETATION, Print.001)


RS
TV
FV
BV
LS
BS

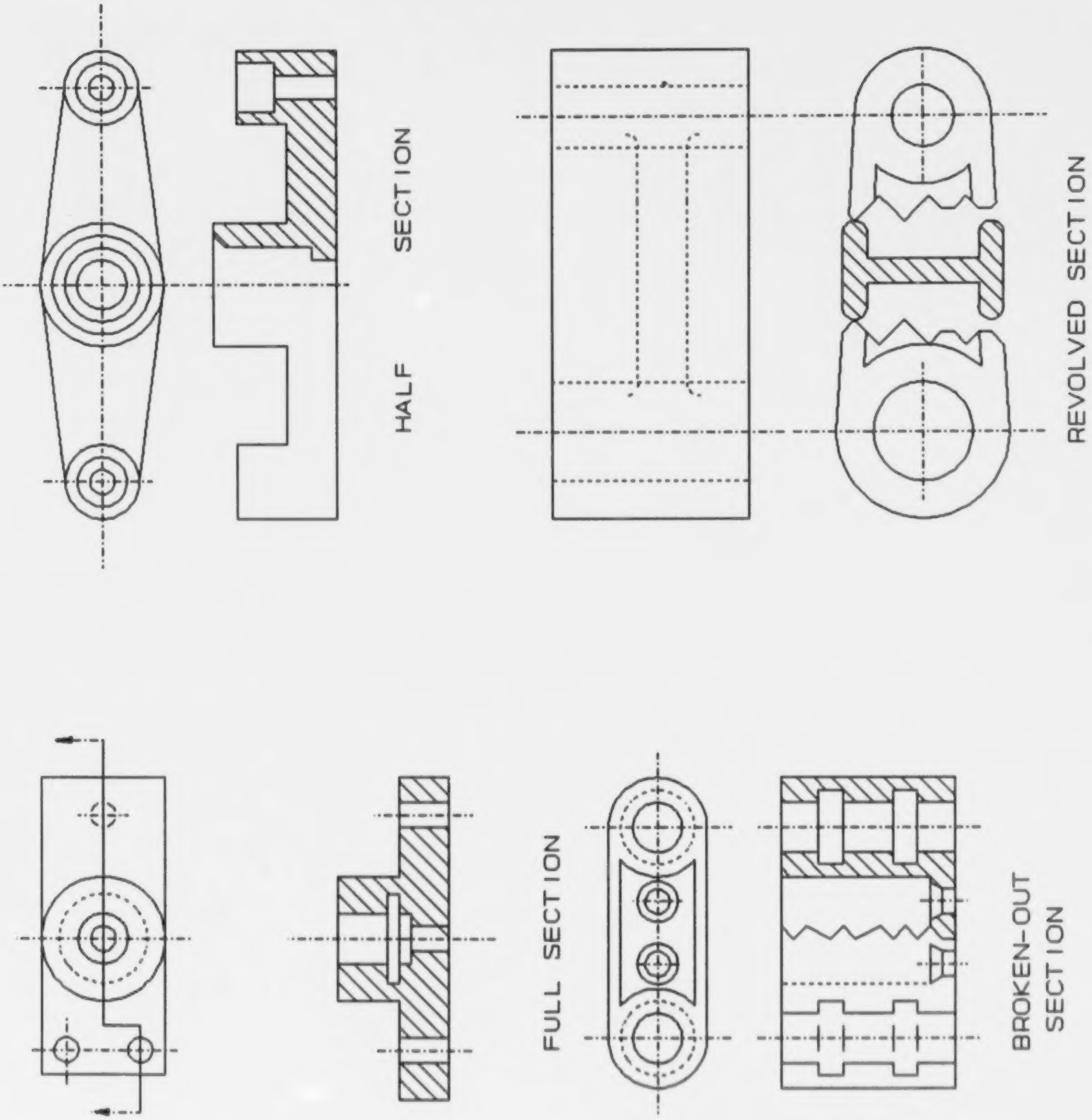
Print.001/Fig. 3. Six Views of Multiview Drawing (PRINT INTERPRETATION, Print.001)


SHAPES ON 2-D PLANE
A.
B.
C.
D.

Print.001/Fig. 4. Examples of Necessary Views to Depict Objects (PRINT INTERPRETATION, Print.001)



Print.001/Fig. 5. Example of an Auxiliary View (PRINT INTERPRETATION, Print.001)



HALF SECTION

REVOLVED SECTION

FULL SECTION

BROKEN-OUT SECTION

Print.001/Fig. 6. Examples of Common Section Views (PRINT INTERPRETATION, Print.001)

With all sides slanting back, isometric projections look similar to what the eye is accustomed to viewing. This makes isometrics easier for untrained personnel to understand than multiviews. Isometrics are often exploded to show assembly of parts. Isometrics can be scaled parallel to their axis for technical purposes. The difficulty with isometrics is they do not show true shape, and they show only one view of an object, leaving three sides unseen.

Oblique projections have commonalities with both isometrics and multiviews. Oblique projections show one size in true shape with the receding sides scaled and shown at an angle. This makes them pleasing to the eye, yet allows one true surface for presenting accurate information. Like isometrics, they leave three blind sides.

Perspectives, obliques, and isometrics are called pictorials because they appear close to what the eye sees.

Detailed drawings are often referred to by other terms such as industrial drawings, engineering drawings, technical drawings, working drawings, and mechanical drawings. The term "mechanical drawing" comes from the mechanical drafting instruments used to produce such drawings. Mechanical drafting methods are progressively being replaced by computer aided drafting (CAD). CAD systems draw much faster. They also have greater design capabilities, being able to manipulate views of the part and simulate it working.

Many special types of drawings are used to convey specific information. Specialized industries, like aircraft, welding/fabricating, architecture, plumbing, and electronics, employ particular types of drawings and symbols. A special type of drawing used in most industries is graphic diagrams. (**NOTE:** Sometimes the term "schematics" is used instead of "graphic diagrams," but correctly speaking, schematics are electrical drawings which show the run of circuits and give specific information about the parts and conductors.) These drawings use special lines and graphic symbols to show the course and parts of electrical circuits, piping, heating, ventilation, air conditioning, etc. Graphic diagrams are used in planning by designers. Builders use them for construction. Also, they are used by maintenance and service personnel for repairs and system upgrading.

Learning Check Sheet: Print.001

Directions:

Based on Student Information Sheet Print. 001, answer the following questions. Use a separate sheet of paper for answers, unless your instructor allows you to use this one.

Questions 1-10, True-False; circle T for true, F for false.

T F 1. Print is another term for an original drawing.

T F 2. Parallel drawings have no vanishing point.

T F 3. Isometric drawings show true shape and size.

T F 4. Mechanical drawings get their name from the drafting instruments used to make them.

T F 5. Auxiliary views are used to show complex internal features.

T F 6. Oblique projections show one side in true shape.

T F 7. The complexity of an object determines the number of views needed to represent it.

T F 8. Isometric drawings are also called orthographic projections.

T F 9. There are six basic views in multiviews.

T F 10. Schematic drawings show surface features.

Questions 11-15, short answers.

11. Name three kinds of pictorial drawings.

    A.
    B.
    C.

12. List three areas using graphic diagrams.

    A.
    B.
    C.

13. What type of view shows true size and shape of an inclined or oblique surface?

14. Why do parallel projections look slightly distorted to the eye?

15. What does "a picture is worth a thousand words" mean?

Learning Check Sheet Answer Key: Print.001

1. F
2. T
3. F
4. T
5. F
6. T
7. T
8. F
9. T
10. F
11. A. Oblique
    B. Perspective
    C. Isometric
12. A. Electrical
    B. Piping
    C. Heating, ventilation, and air conditioning
13. Auxiliary view
14. No vanishing point. Objects do not get smaller as they move away from the point of view.
15. A picture oftentimes communicates much information. Graphic information that equals a large amount of written information.

Student Activity Sheet: Print.001

In order to develop a greater appreciation of graphic communications, you will be instructed to complete one or more of the following activities.

Activity 1. Your team will be given a part or undimensioned drawing of parts, along with measuring tools and sketching materials. Your team will write up an explanation using only words and numbers to describe their part. Parts are kept out of other teams' views. After your team has finished writing descriptions, give the descriptions to another team. (Recommend using simple parts which students can write up in 10-15 minutes.) Using written descriptions, each team will sketch out parts. Sketches are compared to actual parts. The teacher will lead a discussion comparing graphic and verbal communications. Student-generated lists of advantages and disadvantages of each will be put on chalkboard.

Activity 2. For given types of drawings, teams of students will develop bulletin board presentation. The instructor will give your team a given section of bulletin board or wall. Each team develops and arranges examples of types of drawings found in this information sheet. Drawings are labeled with brief explanations. Drawing examples may come from discarded magazines or be photocopied from books or magazines, or you may go to local manufacturers and request extra or unneeded prints.

Alternative Strategies for Activity Number: Print.001

In this activity, teams of students are assigned one type of drawing from the list below. Team develops class presentation, describing their type of drawing and explaining their uses. To reinforce the presentations, all students in class take notes on presentation. Each student uses textbook to find two examples of each type of drawing. For each example, students write down type of drawing and page number.

Types of drawings: (Not limited to only these--at instructor's discretion)

1. Multiviews (basic views)
2. Multiviews (sections)
3. Multiviews (auxiliary)
4. Isometric
5. Oblique
6. Perspective

Learning/Performance Checks: Print.001

Instructor evaluates student learning with completed learning check sheet, answers to oral questioning, and student's contributions to team answers in activities.

Instructor evaluates student performance using observations during team activity. Emphasis is placed on contributions and team membership. A primary consideration is student's ability to transfer information from graphic to written form and back again.

ACTIVITY NUMBER PRINT.002

USES OF DRAWINGS IN MANUFACTURING DEPARTMENTS

Description:

Class develops a video on the use of drawings in various areas of manufacturing. One group is assigned to concentrate on filming; other groups are assigned to develop materials for given areas.

Rationale:

Drawings are widely used in manufacturing. Understanding their broad use enhances an individual's appreciation for the scope of graphic communication in a manufacturing company.

Outcomes:

Upon completion of this activity student will be able to:

1. List manufacturing departments using drawings.
2. Explain and give two examples of how drawings are used in each department.

Tools, Materials, Machines, and Resources:

1. Fales, J., et al. (1986). Mission Hill, CA: Glencoe Pub. Co.
2. Scott, R., et al. (1988). *Drafting fundamentals*. Bennett & McKnight Pub. Co. (pp. 1-14)
3. Video camera, video tape, and VCR.

Instructional Strategy:

Teacher initiates activity with discussion, reading assignment, or any audiovisual media on topic. Instructor explains activity and assigns activity topics to teams of students. Making a video, even a simple one like this, takes a lot of detailed effort. Instructor must work closely with teams of students in order to guide and motivate them.

Safe Practices:

While making video in shop, follow all safety rules both on and off camera.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Print.001

Drawings are the graphic link between various manufacturing departments. Although the basic utilization of drawings is to convey information about a part or assembly, individual departments have specific uses for this information. Some of the departments using drawings are:

A. Research and Development (R&D)
B. Engineering/Drafting
C. Purchasing/Inventory
D. Production
E. Quality Control (QC)
F. Service

Research and Development

Drawings used in research and development (R&D) often are technical sketches or illustrations of new products or processes. Most drawings in this area are temporary, guiding development work and expressing inventive ideas. Because of their temporary nature, R&D drawings are seldom complete detailed drawings.

Thumbnail sketches of inventive ideas help R&D workers to develop new products. As products are developed, R&D workers develop preliminary drawings from which detailed drawings are made.

Engineering/Drafting

Detailed drawings for the production of parts are made in the engineering/ drafting department. Engineers utilize drawings to convey part information to other departments, primarily production. This information covers part size, materials, machining processes, tolerances, and part identification.

The drafting department produces original drawings, which are stored for safety. Also, prints are made of drawings and sent to other departments. Many times, drawings are used to make other drawings. Drawings of component parts are used to make large assembly drawings. "Debugged" drawings from engineering are turned into prints for the entire plant. R&D sketches and preliminary drawings become detailed prints for the production of parts.

Purchasing/Inventory

Purchasing personnel interpret drawings for the purpose of ordering materials necessary for production. Drawings must be carefully read to insure that the ordered materials meet print specifications.

Inventory personnel use prints to help identify parts which are stored and eventually routed to the right destination.

Production

Although some workers in every department need to interpret them, print reading is primarily thought of as a skill for production workers. In order for production to take place, workers must make correct print interpretations. They develop this skill through training and experience.

Production workers use prints for layout, production planning, tooling and machining, assembly, and ongoing inspections. Information taken off prints includes materials, part identification, machining notes, post-machining operations, dimensions, and tolerances.

Quality Control (QC)

Only one of the jobs of QC is final inspection. Incoming materials are inspected for quality and correctness. QC personnel use prints or material specification lists to guarantee the materials are right before the job starts. Production is monitored by QC. This provides early detection of unacceptable parts or procedures, and serves as a double check for production ongoing inspections.

Service

Service departments deal with customer needs regarding the final product. These needs could include installation, part defects, operation problems, routine service, or repairs. Prints convey proper information for production, but this is usually unsatisfactory for service. Service information contains procedures for servicing, operation, and component specifications. Occasionally service personnel use prints; usually, prints are used to develop service manuals, operator guides, and assembly drawings.

Learning Check Sheet: Print.002

Complete the following:

1. List six manufacturing departments which use drawings.

   A.
   B.
   C.
   D.
   E.
   F.

2. Which department uses drawings for layout and setup?

3. Which department uses drawing information for detection of defective parts or processes?

4. Which department uses print information for ordering, storing, and routing parts?

5. Which department uses print information to develop technical manuals for customers?

6. Which department takes preliminary development drawings and turns them into working detailed drawings?

7. Which department uses thumbnail sketches to express inventive ideas?

Learning Check Sheet Answer Key: Print.002

1. A. Research and Development
   B. Engineering/Drafting
   C. Purchasing/Inventory
   D. Production
   E. Quality Control
   F. Service

2. Production

3. Quality Control

4. Purchasing/Inventory

5. Service

6. Engineering/Drafting

7. Research and Development

Student Activity Sheet: Print.002

In this activity, the class produces a 10-20 minute video on the uses of drawing in manufacturing departments. The instructor will break the class into teams. One team will work as a camera crew. The other teams will each be assigned a department. Each team assigned a department will research and write a script for its segment. The instructor may select one narrator for the entire video or one for each department. An outline to guide the activity follows:

1. Research is assigned to a department. The extent of the research depends on the time allotted by instructor. Possible resources include:

   A. Textbooks
   B. Articles in trade or technical journals
   C. Interviews with workers having jobs in assigned departments
   D. Student visits to businesses
   E. Research of libraries

2. Write outline of what will go in team's segment of video. Include key information, demonstrations, and things which will be videoed. Some of the possible things for video taping include photos, drawings, interviews, and actual work in business. Get instructor's approval for content and order. Taping interviews and work in local businesses would prove quite helpful, but it is recommended that the teacher closely supervise any outside taping to protect equipment and guide students. Outside shooting requires extremely careful planning of scenes or necessitates the use of editing equipment.

The following outline may be used to guide the development of the video.

I. List and describe the types of work done in your department.

II. List types of workers in your department who read prints.

III. Describe how these types of workers use prints.

3. Write script for segment. During editing, read script into cassette recorder and record time. Play back and listen for clarity and continuity of thought. Write out a brief description of each scene in the segment to serve as a guide for taping.

4. Practice filming. Film entire video. Then critique it and make plans to improve final filming.

5. Final filming. Do the final taping including credits.

Alternative Strategies for Activity Number: Print.002

Activity 1. This is another video project. This video is taped on a field trip to business and focuses on manufacturing's use of prints. To plan this video, a small team of students (and instructor) need to visit the firm ahead of time. The team advises the class on what to tape and who to interview. After the initial visit, the class discusses and determines what to tape and what questions will be asked in the interview.

Activities such as field trips greatly enhance student learning. This activity focuses student's attention and fosters awareness. There are some limitations. One is that a majority of the work is done by a few students and the instructor. Much effort is put forth to meet only a few objectives. Another restriction is finding a cooperative company with all the required departments is not easy for many schools. Scheduling a field trip sometimes does not coincide with the appropriate unit.

Activity 2. Rather than video taping during the field trip, each student could be given a list of questions to answer. The questions would focus on the use of drawings. The instructor would make up this question sheet based on a preliminary trip or past experience. Grading these questions in class also makes for a good field trip review.

Learning/Performance Checks for Activity Number: Print.002

Instructor evaluates student learning based on learning check sheet, contributions to class discussion, and written script.

A performance check is made of the student's participation in video production. Quality and quantity of research effort will be noted. Initiative and willingness to participate should increase a student's grade.

ACTIVITY NUMBER PRINT.003

NOTES AND DIMENSIONING

Description:

Given prints, students interpret notes and dimensioning, then measure parts and determine if they are within given limits.

Rationale:

Major skills needed to interpret drawings are finding and comprehending notes and dimensions. These elements quickly clarify specifics necessary to precisely describe objects.

Outcomes:

Upon completion of this activity, student will be able to:

1. Identify local and general drawing notes.
2. List methods of dimensioning.
3. Calculate upper and lower size limits.
4. Measure parts and determine if they are within size limits.

Tools, Materials, Machines, and Resources:

1. Taylor, D. L. (1986). Elementary blueprint reading for machinists. Albany, NY: Delmar Publishers. (pp. 52-70)
2. Dimensioning (video). Bergwall Productions, Inc.
3. Parts with prints
4. Semiprecision and precision measuring tools
5. Print Figures .007, .008, .009, and .010.

Safe Practices:

Follow general shop safety rules. Watch for edges when measuring parts.

Instructional Strategy:

Instructor introduces notes, dimensions, and tolerances through reading assignments, video, and discussion. Practical activities enhance student abilities to interpret notes, dimensions, and tolerances.

Integrative Skills

Communication:

__x__ Reading
_____ Writing
_____ Speaking
__x__ Listening

Computation:

__x__ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
_____ Solutions
__x__ Evaluation
_____ Implementation

Graphic communications can convey visual information clearer and simpler than verbal means, but some specific descriptive information is communicated better in writing. Verbal information given on drawings is called notes.

Dimensions are written information stating the sizes or locations of features. Designers and engineers provide dimensions as ideal distances. In reality, actual measurements only come close to ideal. "Degree of precision" is the term for how close to ideal a measurement comes. The acceptable range of measurements is called the "tolerance."

Two types of notes exist, general and local. General notes are placed in the lower right or upper left corner of the drawing or in the title block. The term "general" is used because they provide information pertinent to the entire drawing. Local notes point out information applicable to a specific location such as those found in Print.003/ Fig. 7. Leader or dimension lines identify where local notes apply.

Examples of general notes:

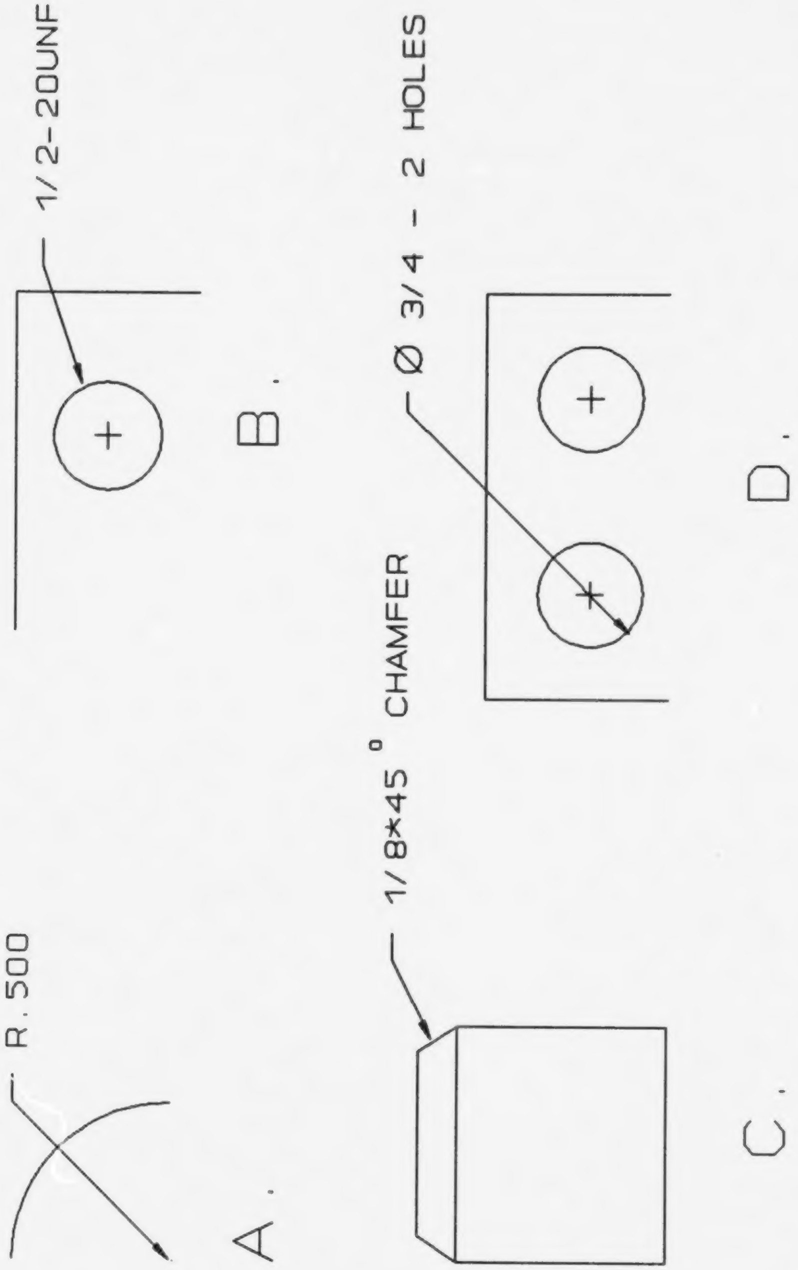
- Break all corners to 1/8" R.
- Unless noted, all fillets and rounds are 1/4" radius.
- **METRIC** (indicates dimensions are SI metric).
- All 0.xxxx" dimensions ±0.0001".
- Finished dimensions: add 0.060" for machining surfaces.

Dimensioning follows general rules which aid reader interpretation and drawing clarity. These rules are only guides, often being bent because of the complexity of drawings, preference of the draftsman, or established practices of a firm.

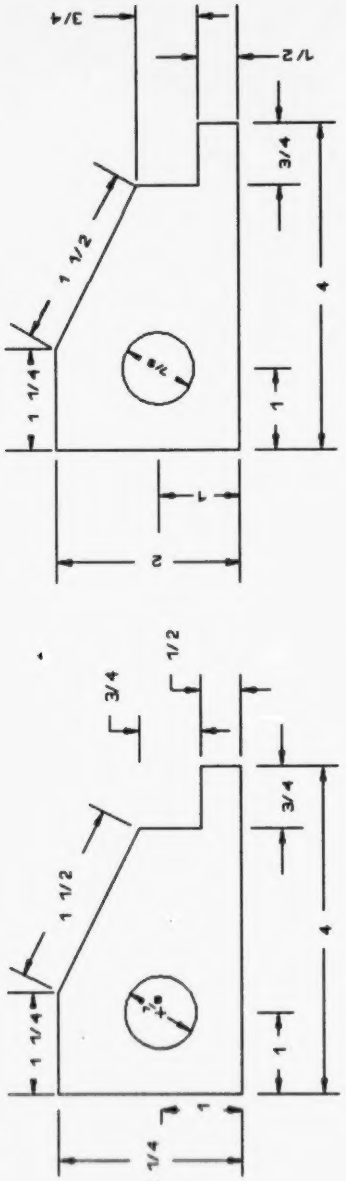
This information sheet examines dimensioning techniques needed for basic size interpretations. Complete coverage of dimensioning and tolerancing rules exist in many sources. Consult these sources when you need more information.

Dimensions are stated in fractions and/or decimals, or else in metric units. No inch or millimeter unit abbreviations are placed behind the dimensions. A general note states when a drawing is metric.

Two styles are used to place dimensions on drawings: unidirectional dimensioning and aligned dimensioning. Print.003/Fig. 8 gives examples of these. Both methods put the specified size in or around the dimension line. All unidirectional dimensions are in line with the


R.500
A.
1/2-20UNF
B.
1/8×45° CHAMFER
C.
Ø 3/4 - 2 HOLES
D.

Print.003/Fig. 7. Examples of Local Notes (PRINT INTERPRETATION, Print.003)


3/4
1/2
1 1/2
1 1/4
7/8
3/4
4
1
1
2
3/4
1/2
1 1/2
1 1/4
3/4
4
1
1
2 1/4

B. ALINGNED DIMSIONS

A. UNILATERAL DIMENSIONS

FIG. 2

Print.003/Fig. 8. Examples of Unilateral and Aligned Dimensioning (PRINT INTERPRETATION, Print.003) bottom of the drawing making them easy to read. Aligned dimensions are aligned with the dimension lines, reading from either bottom-to-top or right-to-left.

Features are dimensioned in only one view, preferably a view that shows true shape. This avoids double "superfluous" dimensioning which unnecessarily clutters drawings. Notice all the extra dimensions found in the examples in Print.003/Fig. 9. Overall dimensions are usually given for width, depth, and height. With an overall given, one of the other dimensions is left out since it can be easily calculated.

Tolerancing is an essential and easy to master part of drawing interpretation. Most tolerances are given in the tolerance sections of the title block. The range of tolerance depends on the precision needed for the part to function. Tolerances determine the lower and upper size or location limits. Lower and upper limits are found by taking the specified dimension and simply subtracting and adding the tolerances.

Examples of finding upper and lower limits.

Given: Specified dimension of 2.500" with tolerance ±0.005".

	2.500"		2.500"
-	.005"	+	.005"
Lower Limit	2.495"	Upper Limit	2.505"

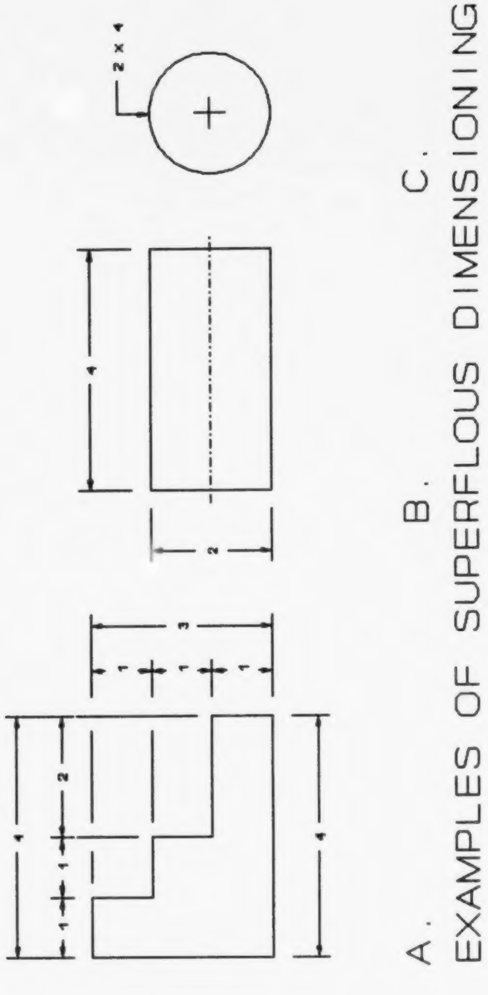
Given: Specified dimension of 0.875" with a tolerance of +0.00/-0.010".

	0.875"		0.875"
-	.010"	+	.000"
Lower Limit	0.865"	Upper Limit	0.875"

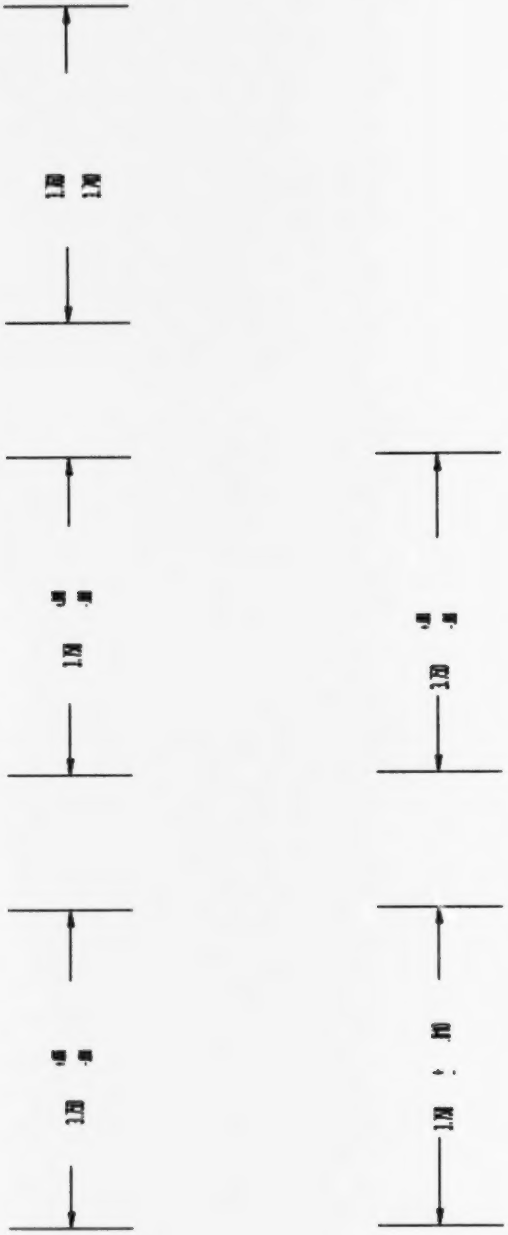
Given: Specified dimension of 1 1/2" with a tolerance of ±1/32".

	1 1/2"		1 1/2"
-	1/32"	+	1/32"
Lower Limit	1 15/32"	Upper Limit	1 17/32"

Some drawings include the tolerances with the dimensions rather than in the title block. The three ways of doing this are bilateral tolerancing, unilateral tolerancing, and limit dimensions. Print.003/ Fig. 10 gives examples of these.


A.
B.
C.
EXAMPLES OF SUPERFLOUS DIMENSIONING
4
2
1
1
3
4
2
4
2 x 4

Print.003/Fig. 9. Examples of Superfluous Dimensioning
(PRINT INTERPRETATION, Print.001)



Print.003/Fig. 10. Examples of Tolerancing Dimensions
(PRINT INTERPRETATION, Print.003)

Learning Check Sheet: Print.003

1. What are the two ways dimensions are arranged on a drawing?

   A.
   B.

2. List three possible reasons for bending dimensioning rules.

   A.
   B.
   C.

3. What is the term for verbal information put on a drawing?

4. What determines the tolerance range for a dimension?

5. What types of notes apply to a specific point on a drawing?

6. List the three types of tolerancing found on drawings.

   A.
   B.
   C.

7. How are upper and lower dimensions found?

8. What does superfluous dimensioning mean?

Learner Check Sheet Answer Key: Print.003

1. Unilateral dimensioning and aligned dimensioning

2. A. Company policy
   B. Complex drawing
   C. Preference of draftsman

3. Notes

4. Function or precision required of part feature

5. Local note

6. A. Unilateral tolerancing
   B. Bilateral tolerancing
   C. Limit dimensioning

7. Tolerance is subtracted and added to specified dimension

8. Doubled or unnecessary dimensions

Student Activity Sheet: Print.003

The instructor assigns you individually or in teams to complete one or more of the following activities:

1. Given part, print, and measuring tools, measure features and determine if measurements are within limits of tolerance.

2. For a given print, answer the following:

   A. What type of dimensioning is used on the print?

   B. How many dimensions are given on the front view?

   C. Are there any local notes on the side view?

   D. List all general notes not found in the title block.

   E. What are the upper and lower limits of the overall width?

Your instructor may assign other questions pertinent to print selected.

3. Given a part, measuring tools, and undimensioned print, students do the following:

   Step 1. Measure parts

   Step 2. Determine tolerances from title block

   Step 3. Dimension print using bilateral tolerancing

Alternative Strategies for Activity Number: Print.003

Given detailed drawings matching parts, the instructor randomly selects students to do the following:

1. Interpret local notes
2. Interpret general notes
3. Find tolerances for given dimensions
4. Calculate upper and lower limits
5. Identify the systems of dimensioning and tolerancing

Learning/Performance Checks for Activity Number: Print.003

The instructor checks student learning with score on learning check sheet and written responses on activity. Since this information sheet is very broad, the instructor might have to supplement it with more specific reading and practice assignments.

The instructor evaluates student performance through observation in activity participation and skill usage. Particular attention is given to use of measuring tools and the ability to read prints.

ACTIVITY NUMBER PRINT.004

DETERMINING MATERIAL REQUIREMENTS

Description:

Students interpret a drawing in order to fill in a bill of materials.

Rationale:

A decisive skill for anyone making production determinations is calculating the specific quantity and material size requirements of parts from detailed drawings. Students demonstrate ability to read prints and decide on material requirements.

Outcomes:

Upon completion of this activity, student will be able to:

1. Identify materials from print.
2. List three sources for materials.
3. Explain and describe the columns in a bill of materials.
4. Fill in a bill of materials.

Tools, Materials, Machines, and Resources:

1. Mather, H. (1987). Bill of materials. Dearborn, MI: Society of Manufacturing Engineers.
2. Wright, R. T. (1987). Processes of manufacturing. South Holland, IL: Goodheart-Willcox Company Publishers. (pp. 415-417)
3. Materials list sheet.
4. Detail drawing with all information necessary to fill in bill of materials block.
5. Use Print.007/Fig. 11 and Print.007/Fig. 12. Other examples of bills of materials are found in PRODUCTION PLANNING & CONTROL, .004.

Instructional Strategy:

Instructor exposes students to basic concepts for bills of material through reading, lecture, and illustrated examples on board or overhead transparencies. Students complete written exam on filling in a bill of materials block and instructor-guided practical exercise. Teams of students complete print interpretation activity regarding bills of materials.

Safe Practices:

If for any reason you go to the shop during this activity, follow shop safety rules.

Integrative Skills

Communication:

___x___ Reading
______ Writing
______ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

______ Assertiveness
______ Negotiation
______ Listening
______ Risk Taking

Change:

______ Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications______________________________

Decision Making:

______ Ethical Reasoning
___x___ Logical Reasoning
______ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
___x___ Implementation

Learning Check Sheet Number: Print.004

The interpretation of detailed drawings used in the manufacture of assemblies often involves determining material requirements. These include identifying materials of which the part is made, as well as size and quantity. This information serves many purposes. It can be used to figure costs, order materials, estimate machining time, or control inventory.

Many detailed drawings include a bill of materials block. This block contains a list of all parts used in the one completed assembly. These parts might come from several sources such as plant inventory, outside suppliers, or be machined from stock. Information in the bill of materials usually describes the part after machining, so when calculating raw stock, extra material must be added.

For each part, the bill of materials lists specifications. These include description, size of stock, material, and required number. Depending on the company's practices, the bill may contain other information on where a drawing of the part may be found or part number used for routing and inventory. Many times a column is found which specifies post-machining processes such as heat treating, anodizing or plating.

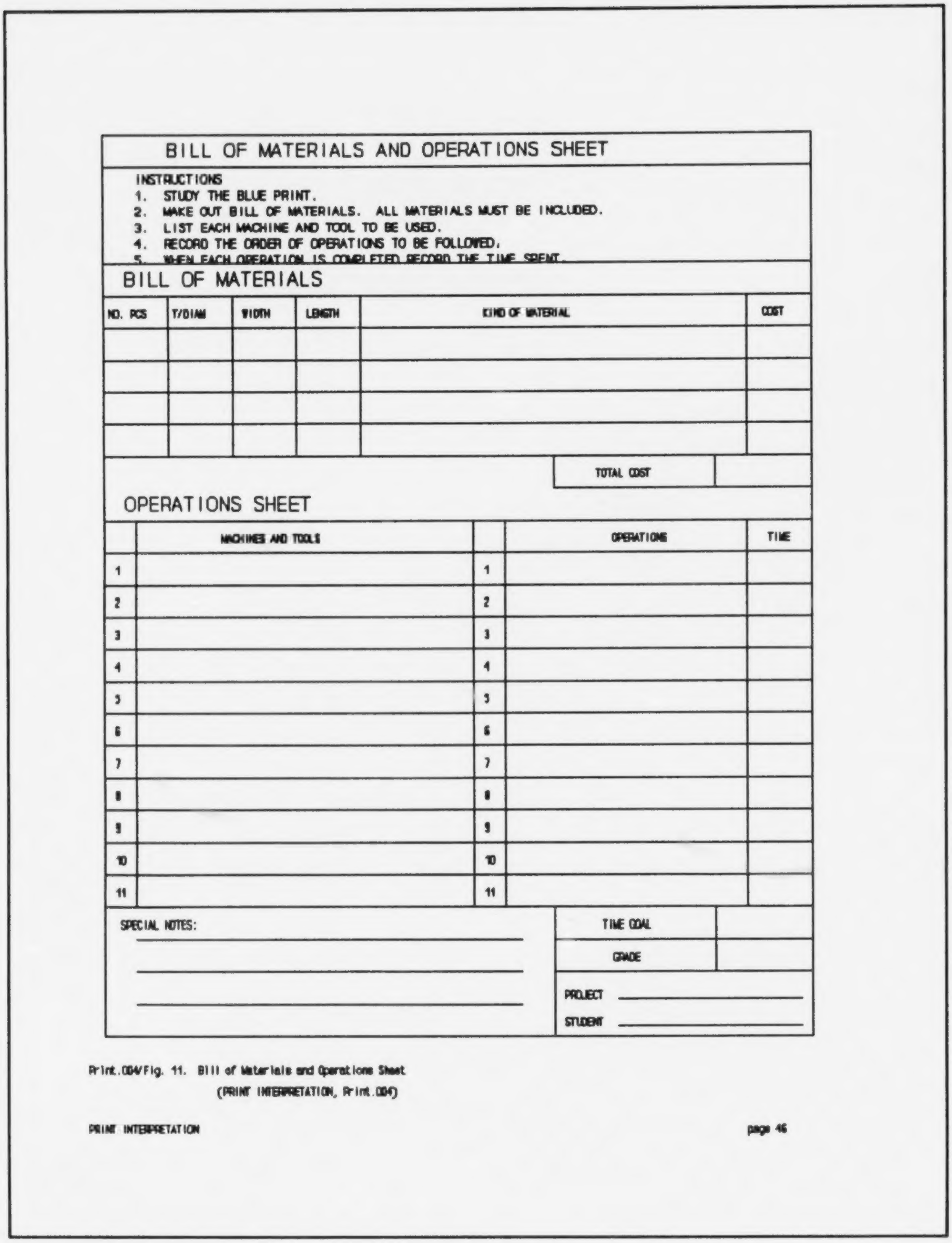
The description column gives a standard name for the part which helps clarify shop communications.

The column listing stock describes finished sizes, nominal thread sizes, or the pre-machining processes. With finished nominal sizes usually given, extra material must be allowed for machining on raw stock. Pre-machining processes include those used to make the part such as casting or welding.

The material column identifies what type. The number represents how many are needed to make one assembly.

Figuring out a bill of materials is a necessary skill. Designers usually complete one when making up a set of detailed drawings. A supervisor, machinist, or material handler also needs this skill. Occasionally a drawing will have no bill of materials, and a person making decisions about the production of the part or assembly will have to be able to read the drawing and determine the materials.

Many types of bills of material are commonly used in industry. Most school shops have one for student use. Print.004/Fig. 11 is a typical high school shop form. Another example is found in the activity PRODUCTION PLANNING AND CONTROL.



BILL OF MATERIALS AND OPERATIONS SHEET

INSTRUCTIONS
1. STUDY THE BLUE PRINT.
2. MAKE OUT BILL OF MATERIALS. ALL MATERIALS MUST BE INCLUDED.
3. LIST EACH MACHINE AND TOOL TO BE USED.
4. RECORD THE ORDER OF OPERATIONS TO BE FOLLOWED.
5. WHEN EACH OPERATION IS COMPLETED RECORD THE TIME SPENT.

BILL OF MATERIALS

NO. PCS	T/DIAM	WIDTH	LENGTH	KIND OF MATERIAL	COST

TOTAL COST

OPERATIONS SHEET

	MACHINES AND TOOLS		OPERATIONS	TIME
1		1		
2		2		
3		3		
4		4		
5		5		
6		6		
7		7		
8		8		
9		9		
10		10		
11		11		

SPECIAL NOTES: ______

TIME GOAL

GRADE

PROJECT ______

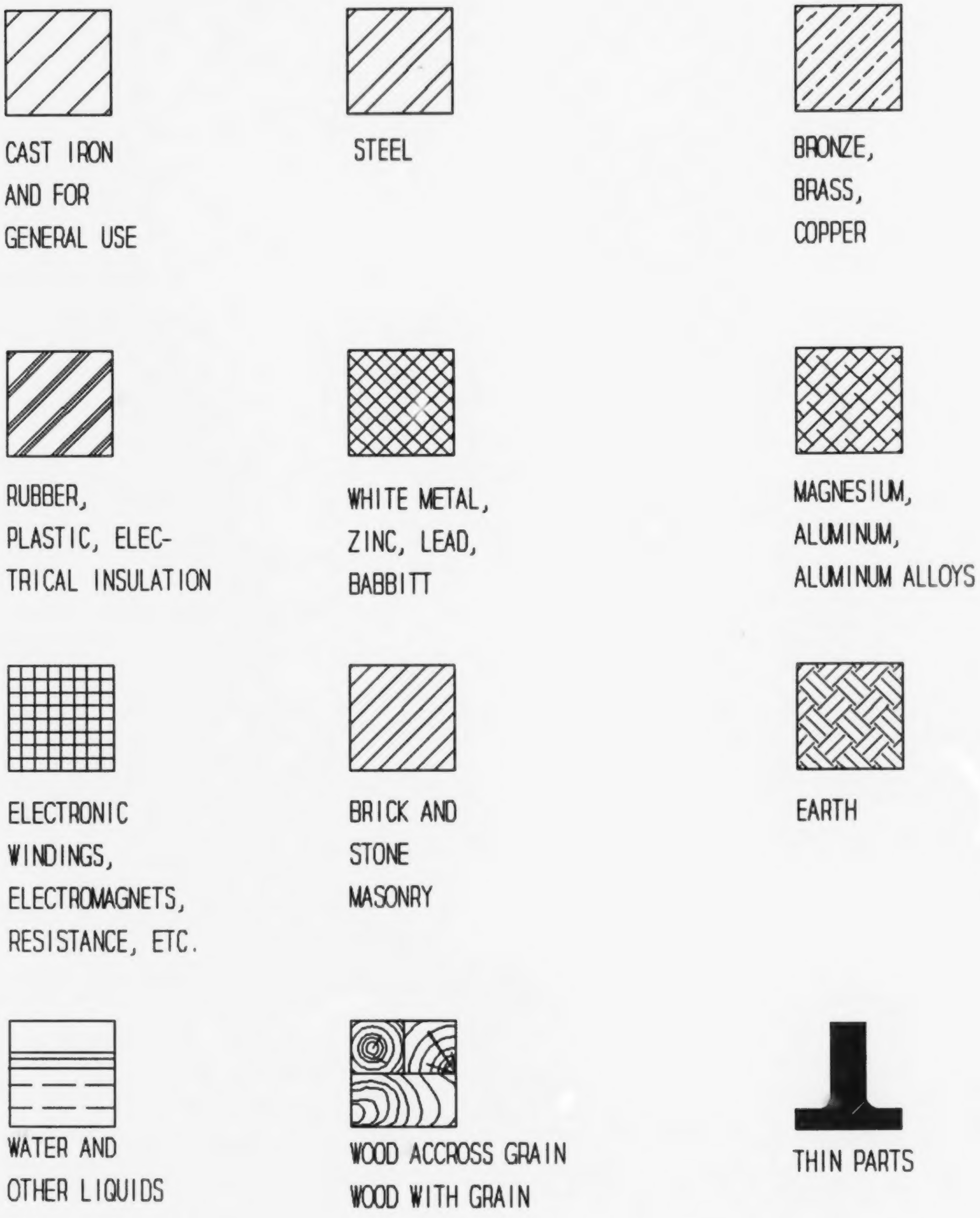
STUDENT ______

Print.004/Fig. 11. Bill of Materials and Operations Sheet
(PRINT INTERPRETATION, Print.004)

PRINT INTERPRETATION page 46

Several ways exist to identify materials from a print. Most prints have a blank in the title block specifically for materials. The material used is so crucial that it is seldom left unspecified. Some prints use a general note to indicate materials; many times, the bill of materials specifies the materials.

Occasionally, a section drawing shows the general classification of materials with cross-hatching section lines. A general classification of materials is not a specific identification; it does not distinguish one type of steel from another. Standard symbols exist for sections lines. Materials are simply distinguished by their symbol lines. Print.004/Fig. 12 includes the basic section symbols.



CAST IRON AND FOR GENERAL USE

STEEL

BRONZE, BRASS, COPPER

RUBBER, PLASTIC, ELECTRICAL INSULATION

WHITE METAL, ZINC, LEAD, BABBITT

MAGNESIUM, ALUMINUM, ALUMINUM ALLOYS

ELECTRONIC WINDINGS, ELECTROMAGNETS, RESISTANCE, ETC.

BRICK AND STONE MASONRY

EARTH

WATER AND OTHER LIQUIDS

WOOD ACCROSS GRAIN
WOOD WITH GRAIN

THIN PARTS

Print.004/Fig. 12. American National Standards Institute (ANSI) Sectioning Symbols (PRINT INTERPRETATION, Print.004)

Learning Check Sheet: Print.004

Answer the following:

1. List four purposes of materials requirement information.

   A.
   B.
   C.
   D.

2. Where is a list of all parts used in one completed assembly found?

3. List three sources for parts found in the bill of materials.

   A.
   B.
   C.

4. Name four specifications the bill of materials lists for each part.

   A.
   B.
   C.
   D.

5. Who usually makes up a bill of materials when detailed drawings are prepared?

Basing your answers on the bill of materials in Information Sheet Print.004, complete the following:

6.

7.

8.

9.

10.

Learning Check Sheet Answer Key: Print.004

1. A. Figure costs
   B. Order materials
   C. Estimate machining time
   D. Control inventory

2. Bill of materials block

3. A. Inventory
   B. Outside suppliers
   C. Machined from stock

4. A. Description
   B. Size of stock
   C. Number required
   D. Type of material

5. Designers

6.

7.

8.

9.

10.

Student Activity Sheet: Print.004

In this activity, the instructor will give you a set of detailed drawings with a partially completed bill of materials. The only information provided in the bill of materials is that not found on the drawing. The instructor may assign this individually or in teams.

In completing the bill of materials, you must do the following:

1. Name and list all parts in the item column of the bill of materials.

2. Find or give each part a number; place in part number column.

3. Identify material for each part and list it in the material column.

4. Determine finished overall dimensions or size of fasteners; then fill these in size column under thickness, width, and length.

5. Decide how many of each part is needed and fill in the number needed column.

6. **OPTIONAL:** The instructor may give you catalogs containing these parts or stock from which they are made. If so, you must price materials and make up a cost estimate for them.

Alternative Strategies for Activity Number: Print.004

Although for the first time it might be best to have students make out a bill of materials as a stand-alone activity, this activity should be used as one step in broader activities such as cost estimating or planning production runs.

Activity 1. The instructor provides students with print and completed bill of materials. Preferably this print is of a part which will be made in a class production run. The instructor tells students how many finished assemblies will be needed. Students calculate total materials for all products. Inventory is checked to see what materials are on hand and which need to be ordered.

Activity 2. The instructor provides students with an assembled product and blank bill of materials. Students disassemble product, measure and sketch out parts, then fill in the bill of materials. The purpose of working backwards is that occasionally workers have to duplicate a part which has no drawing or specification.

Learning/Performance Checks: Print.004

The instructor evaluates each student's learning based on learning check sheet and accuracy of completing bill of materials. While students are working on this activity, individual questions will help guide students and check student understanding.

Performance is evaluated based on student's participation in activity. Considerations for the evaluator should include effort, neatness, and thoroughness.

ACTIVITY NUMBER PRINT.005

PRODUCTION PLANNING FROM PRINTS

Description:

Based on given prints, students plan production operations by completing flow charts and operation sheets.

Rationale:

Businesses, especially competitive manufacturing enterprises, must make accurate and developed plans to guide production. Students must learn the value of print reading as a part of planning.

Outcomes:

As a result of this activity, student will be able to:

1. Given a print, identify and arrange machining, assembling, finishing, and handling operations.
2. Prepare a process flow chart.
3. Prepare an operations sheet for each part.

Tools, Materials, Machines, and Resources:

1. Gessner, R. (1986). Master production schedule planning. Dearborn, MI: Society of Manufacturing Engineers.
2. Thomas, R., & Jensen, T. (1976). Manufacturing. South Holland, IL: Goodheart-Willcox Company Publishers. (pp. 137-150, 229-248)
3. Wright, R. T. (1987). Processes of manufacturing. South Holland, IL: Goodheart-Willcox Company Publishers. (pp. 414-420)
4. Project Planning for Engineers (Video Series): Planning (Part 1) and Planning (Part 2). (1985). Dearborn, MI: Society of Manufacturing Engineers.
5. Use Print.005/Fig. 13 (Operations Sheet), Print.005/Fig. 14 (Flow Chart), and Print.005/Fig. 15 (Flow Diagram). Other examples of these are found in PRODUCTION AND PROCESS CONTROL.002 and PRINT INTERPRETATION.004.

Instructional Strategy:

Instructor introduces activity with review of the role print reading has in planning. Instructor uses reading assignments, lecture, demonstration, and audiovisual means to teach basics of flow chart and operations sheet planning. Students interpret prints to complete these planning sheets.

Safe Practices:

When planning for machining and material handling, students must consider proper safety practices.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Successful manufacturing requires many elements. One of these is planning production operations. Most manufacturing is never started without proper planning. The critical area for planning is production. Production planning involves ensuring materials are on hand, machine time allocated, tooling designed, and operations arranged in a logical order.

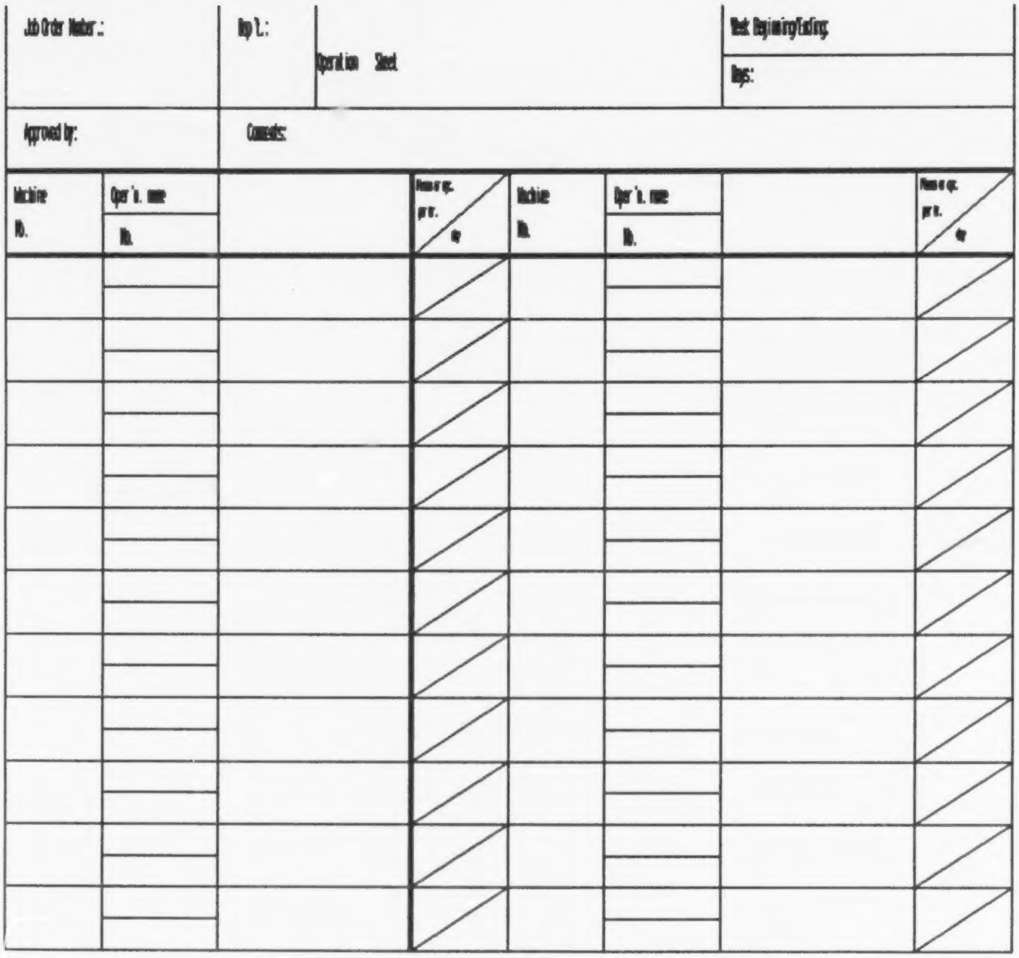
A method to help organize the planning process is to use charts or diagrams to schedule operations. The most commonly used organizers are operation sheets, flow charts, operation process charts, and flow diagrams. Sometimes all four of these are used together; usually, only two or three are needed for adequate planning.

An operations process sheet (see Print.005/Fig. 13) is made out for each part. This sheet lists in proper order all the production processes to be done to the part. For each machining operation, the following are listed: machine to be used, tooling put on machine, set-up time, and production rate. Operation sheets are detailed procedures which aid in starting production and a guide for improving production.

Flow charts (Print.005/Fig. 14) track one part as it moves through production operations. Unlike the operations sheet which lists machining operations, the flow chart lists all processes including operation, transportation, inspection, delay, and storage. A graphic symbol representing each helps workers to visualize the flow of the part from operation to operation.

An operation process chart tracks all the parts for one assembly. These are arranged in side-by-side columns. With all parts and operations listed in columns, machines and times are sequenced much easier. This helps determine when one part must be ready to join with others.

Flow diagrams graphically track the movement of parts from one machine to another on a plant layout. Print.005/Fig. 15 is a typical example of a simple flow diagram. A major advantage of these is they help visualize an orderly flow from one work station to another. Shorter, less crossing paths indicate smooth and efficient flows.



Job Order Number:

Dep't.:

Operation Sheet

Week Beginning/Ending:

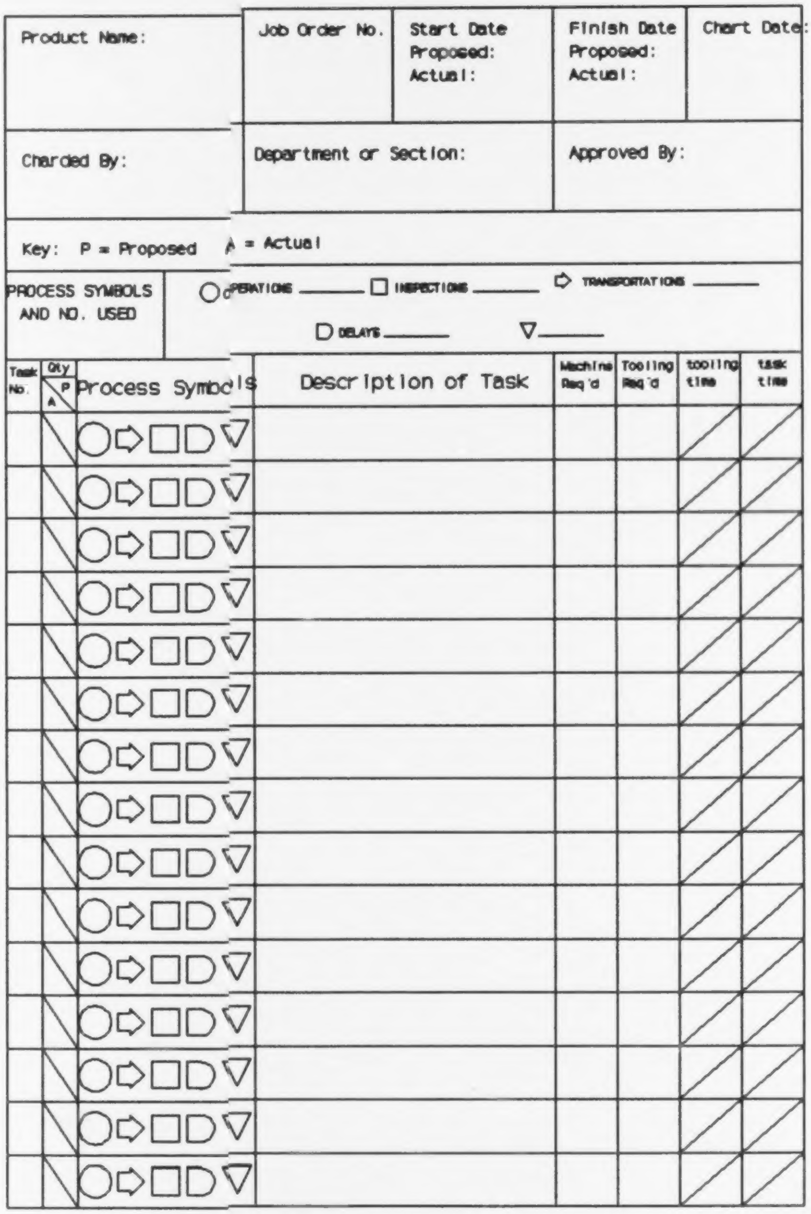
Days:

Approved by:

Comments:

Machine No.	Oper's. name No.		Piece or op. per hr.	Machine No.	Oper's. name No.		Piece or op. per hr.

Print.005/Fig. 13. Operations Sheet (PRINT INTERPRETATION, Print.005)



Product Name:	Job Order No.	Start Date Proposed: Actual:	Finish Date Proposed: Actual:	Chart Date:
Charded By:	Department or Section:		Approved By:	

Key: P = Proposed A = Actual

PROCESS SYMBOLS AND NO. USED ○ OPERATIONS ______ □ INSPECTIONS ______ ⇨ TRANSPORTATIONS ______ D DELAYS ______ ▽ ______

Task No.	Qty P/A	Process Symbols	Description of Task	Machine Req'd	Tooling Req'd	tooling time	task time
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					
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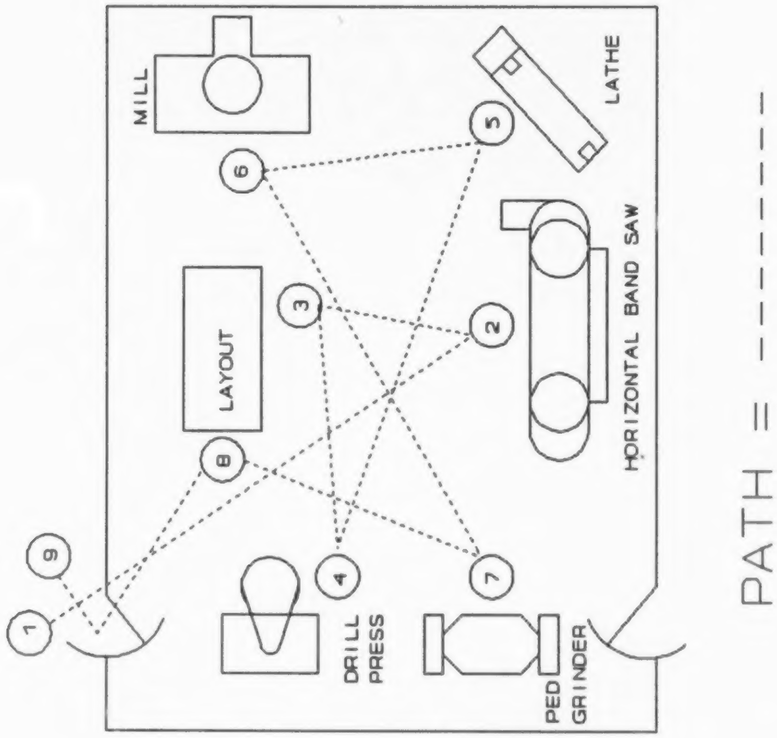
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					
		○ ⇨ □ D ▽					

Print.005/Fig. 14. Flow Chart. (PRINT INTERPRETATION, Print.005)

TYPICAL OPERATIONS
SEQUENCE:
1. GET MATERIAL
2. CUT STOCK
3. LAYOUT
4. DRILL
5. TURN
6. MILL
7. GRIND
8. INSPECTION
9. STORAGE


1
9
8
LAYOUT
6
MILL
3
4
DRILL PRESS
7
2
5
PED GRINDER
HORIZONTAL BAND SAW
LATHE
PATH = --------

Print.005/Fig. 15. Example of Flow Diagram (PRINT INTERPRETATION, Print.005)

Learning Check Sheet: Print.005

Complete the following:

1. What is one element of successful production?

2. List four elements involved in production planning.

   A.
   B.
   C.
   D.

3. What is one method used to schedule operations?

4. What sheet lists only the machining processes to be done on one part?

5. What sheet lists all production operations for one part?

6. What sheet graphically tracks the movement of parts using a shop layout?

7. What sheet lists all parts and all operations in side-by-side columns?

Learning Check Sheet Answer Key: Print.005

1. Production planning

2. A. Ensuring materials are on hand
   B. Allocating machine time
   C. Designing tooling
   D. Arranging operations in order

3. Charts or diagrams

4. Operations sheet

5. Flow chart

6. Flow diagram

7. Operations process chart

Student Activity Sheet: Print.005

The purpose of this activity is to develop your ability to plan production operations from prints. Your instructor will provide prints, blank operation sheets, and flow chart. You will make up your own operation process chart. This is intended to be a small group activity where each student in the group is given one or two parts for planning, and the whole group plans the entire assembly.

Suggestions for Detailed Drawing

No drawing is provided with this activity because your instructor should select one that is appropriate for your course. When selecting a set of prints, some considerations to keep in mind are:

1. You should have enough knowledge of the machining processes in the print to estimate producing the parts.
2. The machining processes should be simple enough not to require complicated setup.
3. The set of prints should be clear, yet as complete as possible.
4. Information needed to interpret the prints should have been covered in previous graphic activities.

Your group must complete the following steps:

Step 1. Identify all parts which will be produced in your shop. For each part, an operations sheet and flow chart will be needed. Hopefully, the print has enough parts for each student to be assigned one or two parts for planning.

Step 2. You will make out an operation sheet and flow chart for your assigned parts. Members in the group will cross check each other's work.

Step 3. The group will use flow charts to develop an operations process chart for the final assembly.

Step 4. Your group will sketch out a shop area with work and tool stations. A flow diagram of movement of parts through shop during production will then be completed. You will critique flow patterns, looking for jams, extra long hauls, or excessive crisscrossing.

Alternative Strategies for Activity Number: Print.005

Activity 1. Although this activity intends to develop print interpreting ability, it could be included in activities for cost estimating or production planning.

Activity 2. An approach to planning for students who have difficulty visualizing machined products from prints is to give students finished parts and have them to work backwards. Students will fill in operations process chart, flow chart, and operations sheet from the bottom up.

Learning/Performance Checks: Print.005

Instructor evaluates student learning based on learning check sheet and completion of charts in activity. Charts should be checked for thoroughness and proper order of processes.

LAYOUT AND INSPECTION

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UNIT GOALS

1. Select and use appropriate tools for semiprecision and precision layouts and inspections from given prints. (Layinsp.001, .002, .004, .005, and .006)
2. Identify inspection programs and describe incoming, ongoing, and final inspections. (Layinsp.006)
3. Determine part dimensions and arrange layouts for minimum material waste. (Layinsp.002, .004)
4. Explain how workers can lessen the need for layout and inspection using work-saving devices such as templates and jigs and fixtures. (Layinsp.001, .002, .003)
5. Choose appropriate times to construct templates for semiprecision layout and inspection (Layinsp.002, .004)
6. Determine part sizes and arrange layouts for minimum waste. (Layinsp.002)
7. Properly select and construct jigs and fixtures to lessen need for layout in production activities. (Layinsp.001, .003, .005)
8. Describe how workplace ethics influences ethical inspection decisions. (Layinsp.007)
9. Explain the effects of automated inspection processes on manufacturing. (Layinsp.008)
10. Describe and list the purposes of computer-controlled inspection processes. (Layinsp.008)

ACTIVITY NUMBER LAYINSP.001

LAYOUT FOR MINIMUM MATERIAL WASTE

Description:

In this activity, students take prints and materials; then they use three techniques to lay out dimensions of parts for maximum number of parts and minimum material waste.

Rationale:

A major problem in layout is wasted materials. This loss can be minimized with planning and practice. Three simple techniques for laying out dimensions onto stock materials cover nearly all layouts.

Outcome:

Upon completion of this activity, student will be able to:

1. Interpret print dimensions to calculate part sizes for layout.
2. List three methods to arrange dimensions of parts on material for cutting.
3. Arrange pieces for minimum material waste when cutting off pieces from stock shapes.
4. Calculate mathematical layout of squares or rectangles from sheet material for minimum material waste.
5. Arrange and lay out various shaped templates for minimum material waste of sheet materials.
6. Calculate percentage of waste materials after stock is cut off.

Tools, Materials, Machines, and Resources:

1. Olivo, C. T. (1987). Machine tool technology and manufacturing processes. Albany, NY: Thomas Olivo Associates. (pp. 18-26)
2. Measuring and Layout Tools (Apple software; provides correct usage of common measuring and layout tools). (1987). Place: Hearlihy & Co. Pub.

3. Prints from which to lay out parts.
4. Layout tools, layout blue, and layout table.

Instructional Strategy:

Activity is introduced with discussion reviewing layout and reading of information sheet. Instructor should include demonstrations, questioning, and problem solving to check student understanding prior to practical activity.

Safe Practices:

Layout, like all shop activities, poses basic hazards. All shop safety rules must be obeyed.

Integrative Skills

Communication:

__x__ Reading
_____ Writing
__x__ Speaking
__x__ Listening

Computation:

__x__ Fractions
__x__ Decimals
__x__ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Layout appears to be a simple, direct task. For this reason, most inexperienced workers underestimate its importance and the skills needed to perform it well. Properly handling the tools requires an expertise which is only developed with practice. Craftsmen develop layout techniques from training, observations, and trial and error.

One of the major problems inexperienced workers have with layout is material waste. Sometimes the material waste comes from incorrect layout, though it usually comes from careless planning of cuts. Good planning minimizes wasted material when cutting pieces from stock. Many students never give thought to planning; they carelessly cut pieces out of new, full sheets of material.

Materials are very costly. Unnecessary waste quickly adds to the cost of a project or cuts into profit margins. Unplanned cuts can waste 50% or more. With a $30.00 sheet, this is a $15.00 waste. Planned cuts often keep waste under 10% or $3.00 for this sheet, a savings of $12.00.

Besides just saving money, planned cuts can also save work. Properly arranged cuts align multiple parts along both sides of one cut. This leaves little waste. This method works best for cutting methods which leave a workable edge. Always remember to leave an allowance on pieces for machining processes and the width of cutting tool.

Three techniques cover most layout situations of stock materials. These are linear cutoff of stock shapes, measurements, and mathematical calculations, and template arrangements. Linear cutoff of stock shapes layout utilizes stock material with the desired shape of the pieces. A worker only needs to figure the lengths of pieces. One important consideration is which dimension of the part to cut off the stock. See Example 1.

Example 1. Twenty-five pieces of 2"x 4"x 6" are to be cut. If different size stock are available, the worker must decided which of the three piece dimensions to use for lengths of cuts. In this example, the stock room has 10' lengths of either 2"x 4" or 2"x 6" materials. Which stock size should be used for minimum end loss? To solve these problems, you must calculate left over material for each. To do this, multiply the length to be cut off by the total number of pieces. Then subtract this number from the lengths of stock which must be taken from inventory.

Solution:

If cut from 2"x 4", 2 ten-foot pieces (240") must be taken from stock.

Number of pieces times extra dimension equals total length of pieces.

25 x 6 = 150" total stock

Total length of stock minus total length of pieces equals left over.

240" - 150" = 90" left over

If cut from 2"x 6", 1 ten-foot piece (120") must be taken from stock.

25 x 4 = 100" total stock
120" - 100" = 20" left over

Although the 2"x 6" stock is more expensive, much less is wasted in this layout. Also, the worker handles less material.

Another problem for linear cutoff involves planning for pieces of varying lengths. Solutions to these problems are often trial and error. Example 2 illustrates problems of this nature.

Example 2.

Problem: A project requires the following pieces and lengths of 2"x 12" stock:

5 - 6' pieces
6 - 4' pieces
8 - 2' pieces

The warehouse has 2"x 12"x 8' stock. Figure the minimum number of 8' sections needed.

Solution: A glance at the piece lengths shows 4' pieces. Each 8' piece will make 2 of these, so three 8' stock pieces will make the 4' pieces.

One 6' piece and one 2' piece make an 8' piece of stock. Five 6' pieces are needed, so five 8' pieces of stock will take care of all 6' pieces and 5 of the 2' pieces.

There are still three 2' pieces left. One 8' stock piece will make these with only 2' left over.

A total of nine pieces of 2"x 12"x 8' stock are needed.

As one can see, linear layout involves rearranging three-dimensional shapes for cutting off lengths from stock. The other types of layout deal with laying out two dimensional shapes on sheets or plates of the required thicknesses.

Square and rectangular parts can be laid out using measurements and mathematical calculations on sheet materials. The width and length of the sheet material are divided by the width and length of the piece. There are two possible ways to divide the material by the piece. Each way should be tried to get the most pieces. See Example 3. Oftentimes, the material and the pieces must be measured for sizes. This is especially true when not working from prints or with "odds-and-ends" materials.

Example 3.

Problem: You are given a 2 'x 8' sheet of 11 gauge steel. How many 5"x 8" pieces can be made out of this?

Solution 1:

Step 1. Divide sheet width by part width.

24" divided by 5" = 4 with remainder of 4".

Step 2. Divide sheet length by piece length.

96" divided by 8" = 12 with no remainder.

Multiply factor from Step 1 times factor from Step 2 equals total number of pieces.

Step 3. 4 x 12 = 48 pieces dividing width by width.

Solution 2: This solution divides sheet width by piece length.

Step 1. 24" divided by 8" = 3 with no remainder.

Step 2. 96" divided by 5" = 19 with remainder of 1.

Step 3. 3 times 19 = 57 pieces dividing width by length.

One can see that mathematical layout will save materials. The process is simple. Many experienced workers perform it in their heads.

Sheets are not as easy to lay out when complex or multiple parts are to be cut. The simplest remedy to this problem is template arrangement of pieces leaving the least space between them. Arrangement of the parts should not be so complex as to hamper the method of cutting them out. Occasionally, more money is lost in excess cutting time than is saved in lowered material losses. One concern to note in template arrangement, if laying out multiple shapes on the same sheet, make sure to layout correct proportions of pieces. See Example 4. Workers waste extra material if too many of one shape are laid out and too few of another.

Example 4. A project requires three shapes of sheet material. A total of 6 pieces in the ratios of 3, 2, and 1 are needed. These shapes are odd, leaving much waste. The pieces should be arranged to leave the biggest end piece, but maintaining the ratio of pieces for one assembly must be prioritized.

Learning Check Sheet: Layinsp.001

Complete the following:

1. Why do most inexperienced workers underestimate the importance of layout?

2. List three ways workers develop layout abilities or techniques.

   A.
   B.
   C.

3. What is the major layout problem inexperienced workers have?

   Given a sheet of 4' x 8' material costing $75.00, calculate answers for questions 4 and 5.

4. After cutting, 10 square feet went into the scrap bin. How many dollars were wasted material?

5. A new layout method cuts waste from 10 sq. ft. down to 10%. If your shop uses 20 sheets of this material per week, how much money will be saved weekly?

6. List two things planned cuts can save.

   A.
   B.

7. List three techniques which cover most layout situations.

   A.
   B.
   C.

8. What method of layout should be used for 3-dimensional shapes?

9. What method of layout should be used for irregular shapes?

10. What method of layout should be used for laying out squares or rectangles all of one size?

Learning Check Sheet Answer Key: Layinsp.001

1. Layout looks like a simple, direct task.

2. A. Training
   B. Observation
   C. Trial and error

3. Excess waste of material

4. Solution:

   A 4' x 8' sheet is 32 square feet

   Price of sheet divided square feet equals cost per square foot:

   $75.00 divided by 32 sq. ft. equals $2.34 per square foot

   Square footage of waste times cost per square foot equals dollar waste:

   10 sq. ft. times $2.34 = $23.40 cost of waste material

5. Solution:

   Percent of waste times cost of material equals cost of waste:

   10% times $75.00 = $7.50 waste

   Old cost of waste minus new cost equals savings per sheet:

   $23.40 minus $7.50 = $15.90 savings per sheet

   Number of sheets used per week times savings per sheet equals weekly savings:

   20 times $15.90 = $318.00 savings per week

6. Money and work

7. A. Linear cutoff of stock shapes
   B. Measurements and mathematical calculations
   C. Template arrangements

8. Linear cutoff of stock shapes

9. Template arrangements.

10. Measurements and mathematical calculations.

Student Activity Sheet: Layinsp.001

Layout techniques which leave minimum waste take practice to develop. For this activity, use the three layout techniques. Although this activity could be simulated entirely on paper, it is recommended that you actually perform these layouts on stock materials in order to enhance learning. Since there are three types of layout, the instructor may have 1/3 of the class doing each type at one time.

You may receive part and material sizes from several sources. These include teacher work sheet, lists on chalkboard, loose parts, or in prints and stockroom materials. Prints and stockroom are the recommended sources because they are the most realistic.

Steps for linear layout of stock shapes:

Step 1. Get prints of parts which will be made of bar, hex, or round stock.

Step 2. Calculate overall dimensions of parts and add cut off/ machining allowance. Add 1/4", unless instructor gives another figure. This gives dimensions of pieces to be cut.

Step 3. If pieces to be cut are rectangular cubes, determine which dimension can be laid out to keep waste to a minimum with the given stock.

Step 4. Mark stock where pieces would be cut. Calculate leftover stock. Have instructor check your work.

Steps for measurements and mathematical calculations of rectangular cuts of one size on sheet material:

Step 1. Get prints or 2-dimensional parts and materials.

Step 2. Calculate overall dimensions. Add allowance if cutting process makes a kerf or edges are machined.

Step 3. Measure the dimensions of the stock material to be used.

Step 4. Divide width of stock material by width of piece. Find answer.

Step 5. Divide length of stock material by length of piece. Find answer.

Step 6. Multiply step 4 answer by step 5 answer. This is the total for calculating stock width by piece width.

Step 7. Divide width of stock material by length of piece. Find answer.

Step 8. Divide length of stock by width of piece. Find the answer.

Step 9. Multiply step 7 answer times step 8 answer. This is the total for calculating stock width by piece length.

Step 10. Compare step 6 answer with step 9 answer. Determine best pattern.

Steps for template arrangement layout:

Step 1. Get from instructor prints containing multiple parts of same thickness, but different sizes and shapes.

Step 2. Make templates of parts.

Step 3. Arrange templates on stock material for maximum number of pieces.

NOTE: If your parts make one assembly, you must keep the correct ratio of parts. Do not lay out too many of one piece and not enough of another.

Step 4. Have the instructor evaluate your layout.

Alternative Learning Strategies: Layinsp.001

Activity 1. When possible, part design should consider the stock sizes of material for minimum waste. If material is to be ordered, the most efficient stock size should be ordered. This process requires finding out the stock sizes available and laying parts out on paper to determine size for least waste. Although a trial-and-error process, this activity can save materials on many projects.

Activity 2. Integrate this activity into a larger production run activity in cost efficiency. Groups of students compete to produce parts for the least cost. Teams practice cost-cutting techniques in materials, layout, setup, production, and inspection.

Learning Performance Checks: Layinsp.001

Instructor checks learning using students' answers on learning check sheet and discussion/problem-solving questions. Evaluation should concentrate on the students' ability to determine dimensions of parts for layout and choosing the correct layout method.

Evaluation of performance concentrates on students' ability to calculate layouts and apply correct layout procedures.

ACTIVITY NUMBER LAYINSP.002

TEMPLATES FOR LAYOUTS

Description:

Given prints of parts, students construct layout templates which will also be used for semiprecision inspection of parts.

Rationale:

Templates can greatly speed semiprecision layout and inspections. The construction of templates demonstrates understanding of the same fundamentals and skills used to build parts.

Outcomes:

Upon completion of this activity, student will be able to:

1. Identify parts and features which may be laid out with templates.
2. Identify parts and features which may be inspected with templates.
3. Describe and choose different template materials.
4. Given a print, construct templates for semiprecision layout and inspection.

Tools, Materials, Machines, and Resources:

1. Material for templates such as plastic, stencil paper, or cardboard.
2. Mat or utility knives, scissors, sandpaper, etc. for cutting and finishing templates.
3. Prints from which to make templates.
4. Any texts or articles for student references.

Instructional Strategy:

The topic is introduced by discussing the use of templates. Instructor emphasizes how semiprecision templates can be used in layout and inspection, also explaining why automated manufacturing processes have greatly reduced the use of templates. Students read the information sheet and complete learning check sheet. Prints chosen for activity should be within student ability. Examples of templates and demonstrations might be needed to clarify activity before students begin.

Safe Practices:

Making templates involves using knife blades, scissors, and sharp objects. When cutting by hand, slipping blades can easily puncture and cut.

Integrative Skills

Communication:

__x__ Reading
_____ Writing
_____ Speaking
__x__ Listening

Computation:

__x__ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Before automated manufacturing, templates were used much more frequently. With computer memories and programmed machines storing part shapes, workers have less need of templates. Templates provided workers with quick outlines of parts for semiprecision manual layouts and inspections. At the present time, templates are still used for production runs in small shops, special runs in larger shops, in design and development, and repairs. Although used less often, workers still widely use templates. Workers often use templates for machine setup alignments.

Templates greatly reduce the time spent on layout and inspection of multiple like parts. For layout, workers trace the template outline and notched-out features onto the work piece. Tracing a template saves time over standard layout on multiple parts. Templates work well on semiprecision measurements; they are not accurate enough for precision work.

Painstaking effort goes into constructing good templates with close tolerances of +/- 1/32"; often, for ease they are made within +/- 1/16".

This lack of precision is the biggest drawback to template use.

Templates take time to construct, so they must be used on enough parts to justify the effort of making them. Constructing one template can take 3-5 times as long as laying out one part. Another concern with templates is handling and storing without damage. Light and flexible templates are easier to handle, but more prone to damage. Thicker templates are sturdier, but awkward and take more time to construct.

The first step in template construction is material selection. Some of the options are paper, cardboard, stencil board, sheet metal, and Plexiglas. Paper works easily and costs very little. Paper's problems are being frail and quickly distorting, so it is not very accurate. Occasionally, workers glue paper patterns right to the work piece and cut out around it.

Layout personnel find cardboard very similar to paper, but much sturdier. Cardboard cuts a little harder than paper but is not as precise. It stores well, providing the area is dry.

Stencil board makes very suitable and accurate templates. Other advantages are that it works easily, is relatively inexpensive, holds shape, handles easily, and requires minimum storage. Also, it can be bent to lay out around corners or flexed for cylindrical layout. Although resistant to paint, stencil board can be damaged by oils and water. It does not make permanent templates as do metal and Plexiglas.

Many permanent templates are made of sheet metal. Being a rugged material, it resists damage. Experienced workers with basic sheet metal tools make templates with ease. Inexperienced workers seldom make accurate sheet metal templates. Intricate sheet metal templates are very time consuming to make.

The characteristics of Plexiglas make it a good template material. Being clear, it is ideal for inspection purposes, but quickly scratches. Its rigidness allow it to be cut, filed, and sanded to accurate measurements. Average skilled workers can make excellent Plexiglas templates. They are light and easy to handle. Layout workers quickly scribe along the stiff sides of Plexiglas templates. They only work on flat layouts.

Learning Check Sheet: Layinsp.002

Complete the following:

1. When were templates used much more frequently?

2. What are the two main purposes for template outlines?

   A.
   B.

3. List five current uses of templates.

   A.
   B.
   C.
   D.
   E.

4. Average templates are made within what tolerance range?

5. What is the biggest drawback with template use?

6. Compared to laying out one part, how long does the construction of one template take?

7. List five suitable materials for templates.

   A.
   B.
   C.
   D.
   E.

8. What are two advantages that cardboard has over paper as a template material?

   A.
   B.

9. List two materials permanent templates are made of.

   A.
   B.

10. What type of surfaces are Plexiglas templates used on?

Learning Check Sheet Answer Key: Layinsp.002

1. Before automated manufacturing

2. Manual layout and inspection

3. A. Production runs in small shops
   B. Special runs in small and large shops
   C. Design and development
   D. Repairs
   E. Setup alignment

4. +/- 1/32"

5. Lack of precision

6. 3-5 times

7. A. Paper
   B. Cardboard
   C. Stencil board
   D. Sheet metal
   E. Plexiglas

8. Sturdier than paper and stores well

9. Sheet metal and Plexiglas

10. Flat surfaces

Student Activity Sheet: Layinsp.002

Template building exercises one's abilities in print reading, layout, and basic hand-tool skills. Since the quality of many parts depends on one template, making a template requires painstaking effort to ensure correctness.

In this activity, you will make templates of semiprecision parts, layout on stock materials using template, and cut pieces from stock; then measure pieces to determine how close parts are to specified dimensions.

Keep templates small. This saves a lot of material. Paper templates keep the costs down, as well as the time per template. Using donated or saved cardboard increases the construction difficulty. One suggestion is to trace a template onto paper the first time and have your instructor inspect this practice paper before using other materials.

Steps for template activity:

Step 1. Instructor will provide print of semiprecision layout.

Step 2. Select from available template construction materials. The instructor will inform you of optional materials. The first template is usually made of paper.

Step 3. Interpret print and layout template using necessary semiprecision layout tools. Get instructor's approval, then cut out template.

Step 4. Secure template to working material. Mark hole centers and other feature locations. Outline template and any features.

Step 5. Cut working part out of material. Measure part features and compare with print dimensions. Show instructor the work.

Step 6. Teams will exchange parts and inspect them using their own templates. Inspecting team notes any measurement errors on parts. The inspecting team then compares itsinspection to actual measurements taken in Step 5.

Alternative Learning Strategies: Layinsp.002

Activity 1:

The following activity proves the point that templates save time over conventional semiprecision layout. Break the class into even number groups. Take several prints from which students will lay out parts. Pair up two groups and give them each one print. One of the groups will lay out 20-50 parts using conventional layout techniques. The other paired group makes a template of the part and lays out the same number of parts using template layout. Layout times between the two groups are compared.

Activity 2:

After reading information sheet and class discussion on the role of templates in manufacturing, students will write one-half page defining and describing template layouts and inspection. On the other half page, students will describe how automated manufacturing has decreased the need for templates.

Learning/Performance Checks: Layinsp.002

The instructor checks student learning by checking answers on learning check sheet and observing work in group activity. Key points to observe are the selection of template materials and print reading.

Performance checks are based on student performance as member of group. Concentrate observations on tool skills and participation as group member.

ACTIVITY NUMBER LAYINSP.003

JIGS AND FIXTURES TO LESSEN LAYOUT

Description:

Given prints, students design and construct simple jigs and fixtures which lessen or replace bench layout procedures. Parts are machined in jigs and fixtures, then inspected. After inspection, adjustments are made on jigs and fixtures.

Rationale:

Jigs and fixtures serve several key functions in production. One of these is lessening or eliminating conventional bench layout. Constructing jigs and fixtures from prints illustrates that production steps can be overlapped to save time and consolidate efforts.

Outcome:

Upon completion of this activity, student will be able to:

1. Define jigs and fixtures.
2. List key functions of jigs and fixtures.
3. Describe how jigs and fixtures lessen the need for layout.
4. Interpret prints, sketch out, and construct simple jigs and fixtures.
5. Inspect parts made with jigs and fixtures, then adjust jigs and fixtures for more accurate machining.

Tools, Materials, Machines, and Resources:

1. *Automated manufacturing*. (1987). Springfield, IL: Illinois State Board of Education. (Unit #209)
2. Boyes, W. (Ed.). (1985). *Low-cost jigs, fixtures and gauges for limited production*. Dearborn, MI: Society of Manufacturing Engineers.
3. Prints of parts for which a jig and a fixture can be constructed.

Instructional Strategy:

Instructor introduces topic with lecture, discussion, and reading assignment. Oral questioning and learning check sheet are used to assess learning. Demonstration, slides, or photos of jigs and fixture should be provided to reinforce concepts prior to activity. Instructor should provide guidance and answer questions during practical activity, but student learning through discovery is encouraged.

Safe Practices:

Obey all shop safety rules. Jigs and fixtures must be strong and secure. If not, they could break with parts being hurled about. Keep safety in mind when designing any jigs and fixtures. Have instructor approve any jigs or fixtures prior to machining.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

__x__ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Jigs and fixtures (J&F) hold and align the work for machining operations. By definition, jigs hold a workpiece and serve as a guide for a tool; jigs may or may not be attached to a machine. Examples of typical jigs are a guide for drilling or a block with dowels for bending scrolls. Fixtures hold work in alignment with the machine, but do not guide the tool. One type of fixture holds a connecting rod in position while different milling operations are completed.

Operators use J&F for repeated machining operations on duplicated parts. Since J&F insure identical machining, accurate and interchangeable parts are made. The J&F position parts and guide tools, so workers spend less time on layout and setup. Machine operators measure less and make fewer machine adjustments. The machining of duplicate parts requires fewer inspections. Instead of inspecting every part, every 10th or 50th part is checked.

It would not be practical to buy or construct J&F for only a few parts. Companies should justify the added expense. Jigs are reusable, often adjustable or have guides for different size tools. Some manufacturers specialize in flexible fixtures and clamps which are adjustable, easy to setup, and allow quick part lock/release.

Layout work scribes locations and outlines features to be machined onto work pieces. J&F eliminates the need for much of this work. Locations of machined areas are determined by the guide of the jig and some fixtures. Other fixtures only position pieces relative to the axes of the machine, saving some layout, but not all.

The construction of J&F requires time and expertise. Workers building or buying J&F should consider several things. Will the cost of the J&F be paid for by its savings? Will it have future use? Is it cheaper to make one or buy one? Do the workers have the skills and tools necessary to build it? Production planning and control decision makers should consider these questions before production begins. These decisions test their abilities in print reading, layout, machining, and production planning.

Self-aligning NC/CNC machines eliminate most of the need for positioning fixtures. Most workers still occasionally use these skills. Furthermore, the concepts behind J&F relate to programming and setup of computer-controlled machines.

Learning Check Sheet: Layinsp.003

Complete the following:

1. Define a jig.

2. Define a fixture.

3. Jigs and fixtures insure the identical machining of ______________ and ______________ parts.

4. Jigs and fixtures save workers time doing what five things?

   A.
   B.
   C.
   D.
   E.

5. List three characteristics of a flexible fixture.

   A.
   B.
   C.

Discuss the following:

1. What items would you consider when comparing costs and savings of jigs and fixtures?

2. What possible ways could jigs and fixtures be reused in the future?

3. How could you find out if workers had the skills and tools needed to build a jig or fixture?

Learning Check Sheet Answer Key: Layinsp.003

1. A jig holds a workpiece and serves as a guide for a tool.

2. A fixture holds work in alignment with a machine, but does not guide the tool.

3. Accurate and interchangeable.

4. A. Layout
   B. Setup
   C. Measurements
   D. Machine adjustments
   E. Inspections

5. A. Adjustable
   B. Easy to set up
   C. Allow quick part lock and release

Student Activity Sheet: Layinsp.003

In this activity, your instructor will divide class into an even number of groups. One-half of the class will make a part using a jig and a fixture. The other half will make a part without using any jigs or fixtures. In order to demonstrate that jigs and fixtures only save time on certain parts, the instructor assigns a variety of parts among the groups. This will show you that J&F are helpful in some productions and not in others. At least one part should be a quantity of 1, another a quantity of 10, and another at least 20.

This activity has groups compare making parts with J&F and without. To do this, use the following steps as a guide:

Step 1. Divide class into an even number of groups. Even-numbered groups will use or construct J&F to produce their parts. Odd-numbered groups will build parts without using J&F.

Step 2. Instructor assigns each group three parts to be made from prints. One part should be complex, challenging student layout ability. The second part should be average for student ability. The third part should be simple to make. All parts should have features, such as holes, slots, grooves, etc., for which J&F can be made.

Step 3. Each group makes the following quantities of each part. One of the complex part, five of the average part, and 20 or so of the easy part. Students record time to make required quantities of each part.

Step 4. When all parts are completed, instructor leads class discussion in which groups provide and compare their answers to the following questions:

1. How long did it take groups to make the quantity for each part?
2. Which groups took the least time?
3. Were these groups using J&F or not?
4. If they were not using J&F, why did they make their quota faster?
5. If they were using J&F, why did they make their quota faster?

Step 5. Class develops a general rule for when to use J&F. This rule includes when J&F are a worthwhile effort, when it does not matter, and when time would be wasted in setting up and constructing J&F.

Alternative Strategies for Activity Number: Layinsp.003

After discussing jigs and fixtures, the instructor assigns groups of students to develop J&F for part(s) to be produced by class. Each group is given prints from which they design, sketch out, construct, set up, and make a first-piece which they inspect. Based on the initial inspection, they adjust or remake J&F to produce a piece until it passes inspection. This activity closely duplicates many tasks performed by setup workers, but it does not stress student ability to determine when J&F are helpful. Instructor should supplement this activity with questioning or a problem solving quiz to help students make decisions about J&F.

Learning/Performance Checks: Layinsp.003

The instructor evaluates student learning with answers to learning check sheet and written responses of activity. Students must understand basic J&F fundamentals in order to make decisions on the use of them.

Instructor observes student performance in reading prints, designing, and constructing parts during activity. Performance evaluation is based on effort, abilities, and skill proficiency.

ACTIVITY NUMBER LAYINSP.004

DEGREES OF PRECISION FOR LAYOUT AND INSPECTION

Description:

Given prints, teams of students layout pieces using semiprecision layout tools. Teams exchange pieces and inspect layouts using precision measuring tools. Groups use inspection results to compare semiprecision and precision layouts.

Rationale:

Workers have to interpret drawings to assess the degree of precision needed for layouts. Using semiprecision layout when precision is required will produce scrap parts. Using precision layout when semiprecision is required will cause unnecessary costs.

Outcomes:

Upon completion of this activity, student will be able to:

1. Given a print, determine semiprecision and precision layouts.
2. Make semiprecision layouts.
3. Inspect layouts using precision measuring tools.
4. List three consequences of making semiprecision layouts when precision was needed.
5. List three consequences of making precision layouts when only semiprecision was needed.

Tools, Materials, Machines, and Resources:

1. Krar, S. F., et al. (1983). Machine tool operations. New York: McGraw-Hill, Inc. (pp. 47-60)
2. Print containing part(s) which requires both semiprecision and precision layout.
3. Both semiprecision and precision layout and measuring tools.

Instructional Strategy:

Instructor introduces topic with review of semiprecision and precision measuring. Questioning or quiz should be used to determine student ability to choose correct measuring tool for the given measurement. Students read information sheet and complete learning check sheet. Instructor guides practical activity ensuring students stay on tasks and use proper tools.

Safe Practices:

When laying out and inspecting, keep on safety glasses and obey all shop safety rules.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

__x__ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications____________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

The **degree of precision** refers to how close an actual measurement is to a specified dimension. **Dimensions** are ideal sizes specified by engineer designers on drawings, in bill of materials, or specification lists. Actual measurements are never exact, only to a degree of closeness. An acceptable degree of closeness, known as **tolerance**, depends on the function of the part or feature. Tolerances are stated as plus or minus a distance from the specified dimension. Adding the plus distance to the specified dimension gives the **upper limit**. Subtracting the minus distance gives the **lower limit**.

Precision means measurements specified within +/- 0.001"(0.02mm) linear or +/- 1/2 degree angular or closer to specified dimensions. Measurements specified with three or more places behind the decimal point are precision. Any measuring instrument which measures this close or closer is a **precision measuring tool.**

Semiprecision are measurements with a wider tolerance range than precision ones. They are stated as either fractional measurements or with one or two place decimals within +/- 0.01"(0.2mm) or +/-1/64". Examples of **semiprecision measuring tools** are rulers, combination square, and transfer calipers.

Most prints give the degree of precision for measurements in a tolerance block or with the dimensions. The worker merely interprets the information on the print. Workers must be able to gather and interpret information of prints in order to make many decisions, including selection of layout methods.

When laying out pieces for production operations, workers should only use the degree of precision specified. Precision measurement takes additional time and uses more expensive tools, so precision layout would waste money if semiprecision would do. Using semiprecision layout, when closer tolerances were necessary, would cause many faulty parts and a lot of wasted money.

Selecting the proper degree of precision for layout is simple. Workers must interpret this information from prints. If prints or specifications are not available, the worker needs to understand the function of the part. Critical functions or locations dictate the need for precision. When in doubt, use precision layout; it is better to waste time than scrap parts.

Learning Check Sheet: Layinsp.004

Complete the following:

1. Define the term "degree of precision."

2. Tolerance depends on what?

3. What are ideal sizes specified by engineers/designers called?

4. How is the lower limit found?

5. A precision linear measurement is at least how close?

6. A semiprecision measurement will have the maximum of how many places right of the decimal point?

7. On most prints, what two places might the degree of precision for measurements be found?

   A.
   B.

8. List two reasons not to use precision layout if semiprecision will do.

   A.
   B.

9. Why would using semiprecision layout when precision was called for be worse than the other way around?

10. When in doubt, what degree of layout should be used?

Learning Check Sheet Answer Key: Layinsp.004

1. Degree of precision means how close an actual measurement is to a specified dimension.

2. Function of the part or feature.

3. Dimensions.

4. Subtracting the minus tolerance from the specified dimension.

5. +/-0.001".

6. Two or written as 0.XX".

7. Tolerance block and on dimensions themselves.

8. Extra time and tools more costly.

9. Scrap parts will be produced.

10. Precision layout.

Student Activity Sheet: Layinsp.004

This activity compares semiprecision and precision layout. You may do this by taking a print with precision and semiprecision dimensions, and using only semiprecision measuring instruments to layout the parts. Layouts are exchanged among other students and inspected with precision tools. You then compare measurements to dimensions. Your teacher may have you do this activity individually or in small teams.

Procedural steps for activity:

Step 1. Given prints, lay out parts using semiprecision measuring tools.

Step 2. Exchange layouts and perform precision inspections.

Step 3. Answer the following for each inspected measurement:

1. Is this a precision or semiprecision dimension?
2. What is the dimension?
3. What is the actual measurement?
4. What is the tolerance?
5. What are the upper and lower tolerance limits?
6. Is the measurement within the tolerance limits? If not, how far beyond the upper or lower limit is the measurement?

Step 4. Count all the semiprecision dimensions. How many failed the inspection? (These would have been "no" answers to question #6 in step 3.)

Step 5. Count all the precision dimensions. How many failed the inspection?

Step 6. Calculate and compare the percentages of inspection failures between semiprecision and precision dimensions.

Step 7. Are there any precision dimensions which passed semiprecision layout? Why?

Alternative Strategies for Activity Number: Layinsp.004

The above student activity can be shortened by simply giving students parts which they measure and record. After making all measurements with semi-precision tools, students are given prints and precision measuring tools. From prints, students determine which dimensions are precision and remeasure these with precision tools. For each precision measurement, they answer all six questions in step #3.

Learning/Performance Checks: Layinsp.004

Instructor evaluates student learning based upon responses on learning check sheet and written answers in activity. Particular attention should be paid to student's ability to differentiate between semi- and precision measurement.

Student performance is checked by observing student's effort in group, skill in using measuring tools, and making required calculations.

ACTIVITY NUMBER LAYINSP.005

CONSTRUCTING LAYOUT AND INSPECTION GAUGING

Description:

Students shorten layout and inspection procedures by constructing gauge blocks and go/no-go gauges.

Rationale:

Layout can be shortened using gaging setup. Many production inspections use go/no-go gauges. Constructing gauges from prints and using them for layouts and inspections enhances student understanding of gauging principles.

Outcomes:

Upon completion of this unit, student will be able to:

1. Describe how layout workers use gauge blocks.
2. Describe how inspectors use go/no-go gauges.
3. List and describe three types of go/no-go gauges.
4. List three advantages of gauges over conventional adjustable measuring devices.
5. Construct gauges and apply basic gauging principles to layout and inspection.

Tools, Materials, Machines, and Resources:

1. Inspection, gaging and testing. (1987). Dearborn, MI: Society of Manufacturing Engineers.
2. Olivo, C. T. (1987). Machine tool technology and manufacturing processes. Albany, NY: Thomas Olivo Associates Publishing Co. (pp. 59-63)
3. Basic Dimensional Measurement Series (Video series and workbooks covering almost every kind of dimensional measuring equipment). (1986). Cleveland, OH: Technicomp Publisher.

4. Measuring and Layout Tools (Apple software on identification and usage of common measurement and layout tools). (1987). Springfield, OH: Hearlihy and Co. Publishing.

5. Prints of parts for which gauges will be constructed.

6. Semiprecision and precision measuring tools for gauge construction.

7. Materials for constructing gauges.

Instructional Strategy:

Instructor introduces topic with discussion/lecture reviewing the fundamentals of layout and inspection. Discussion should lead into gauging short cuts to speed layout and inspection. Students read information sheet and complete learning check sheet. Prior to practical activity, instructor should demonstrate or explain with question checking for student understanding.

Safe Practices:

All shop safety rules must be followed while constructing gauges and applying them in shop activity.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

__x__ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
_____ Evaluation
__x__ Implementation

Layout workers, setup workers, and inspectors often use precision gauges for highly accurate measuring. Some gauges are fixed sizes; others adjust to measure. This information sheet discusses gauge blocks and types of go/no-go gauges. Workers use gauges to set or make measurements. Rather than spending time using conventional measuring tools, workers just compare the place to be measured with the gauge. Occasionally, gauges are used in conjunction with other measuring devices like dial indicators or sine bars. In these cases, the gauges still hold steady measurements for comparison purposes.

Gauges are hardened, durable, and maintain very precise sizes. Micrometers, vernier calipers, and other hand-held, adjustable measuring instruments are not as accurate as fixed precision gauges. Optical comparators, lasers, and other instruments are almost as accurate as precision gauges, but usually operate slower, and require more care and calibration.

Linear or angular distances are set or measured with gauge blocks. Manufacturers machine precision gauge blocks to within microinches of nominal dimensions. Workers wring together the nominal sizes to total a specified distance for comparing or setting measurements. Layout workers use these precision distances to guide or block up parts for scribing and adjusting sine bars. Setup personnel make alignments from gauge blocks or produce gauging plates to expedite size adjustments. Inspectors compare feature sizes to gauge block combinations. Many times for repeated measurements, workers make their own size gauge.

Go/no-go gauges are set to the upper and lower size limits for a dimension. Some are fixed gauges, others adjust slightly. These gauges speed up and cause fewer measuring errors during inspection because workers have no scales to read. If the part is acceptable, it fits between the smaller and larger size. Parts too large can be reworked. Parts too small are scrapped. Examples of go/no-go gauges are snap gauges, ring gauges, and plug gauges. Snap gauges are for linear external dimensions. Plug gauges are used for holes, internal tapers and threads. Ring gauges are used for external cylinder diameters, tapers, and threads.

Because of their accuracy and speed, workers should develop their comprehension and skills in gauging. A practical method to develop this skill consists of designing, constructing, and using gauges for layout, setup, and inspection. Students can easily construct fixed gauges like gauge blocks, snap gauges, and plug gauges. Making precision gauges requires high precision measuring tools and accurate machining. Gauging techniques can be learned faster fabricating semiprecision gauges. Machinists think first of precision gauging, but workers producing parts with sheet metal, wood, and other materials use semiprecision gauges. Regardless of the degree of precision, gauging principles are the same.

Learning Check Sheet: Layinsp.005

Complete the following:

1. Give three types of workers using precision gauges.

   A.
   B.
   C.

2. List one way gauges are better than micrometers or vernier calipers.

3. List two ways optical comparators and lasers are not as good as gauges.

   A.
   B.

4. Gauge blocks are used for what?

5. How close to nominal sizes are precision gauge blocks made?

6. How do layout workers use gauge blocks?

7. What types of gauges are set to upper and lower size limits for a dimension?

8. What type of gauge is used for holes, internal threads, and tapers?

9. What kind of measurements are made with snap gauges?

10. What type of gauge is used to measure external tapers?

Learning Check Sheet Answer Key: Layinsp.005

1. A. Layout workers
   B. Setup workers
   C. Inspectors

2. More accurate

3. Slower and more care and calibration

4. Set or measure linear or angular distances

5. Microinches

6. To guide or block up parts for scribing and adjusting sine bars

7. Go/no-go gauges

8. Plug gauges

9. Linear external dimensions

10. Ring gauges

Student Activity Sheet: Layinsp.005

These activities provide you with practice in making gaging for use in layout and inspection. You will interpret prints to determine gaging requirements, then select or construct appropriate gauges for measurements or settings. Your instructor may choose to have you make either precision or semiprecision gauges. These gauges are made to speed and ease multiple layouts and inspections. Most gauges are small and can be made from scrap, making this an excellent shop activity for print interpretation, layout, machining, and inspection.

Activity 1. Make gaging for laying out distances parallel to surface plate or a reference edge.

Activity 2. Make gaging for laying out angular distances both for angular dimensions and polar dimensioning from reference lines.

Activity 3. Make span gauge to inspect the linear dimension of a feature.

Activity 4. Make a plug gauge by turning two diameter sizes, an upper and lower limit, on a shaft.

Activity 5. Make a ring gauge by boring and reaming two holes, an upper and lower limit, into stock.

Alternative Strategies for Activity Number: Layinsp.005

The principles of gaging for multiple production layouts and inspections can be simulated using a variety of materials. Actual production activities where students make useful gauges is the recommended plan. Simulation activities can save time either using simple shop tools or in the classroom. Very basic gauge simulation activities can be performed using such materials as cardboard, plastic, wood, and sheet metal.

Learning/Performance Checks: Layinsp.005

Instructor evaluates student learning with Learning Check Sheet and display of comprehension in activity. Instructor should use questioning during discussion to check student learning.

Performance checks are made during activity by evaluating student efforts, participation, and demonstrated skills. A primary consideration is to observe student accuracy in gauge making.

ACTIVITY NUMBER LAYINSP.006

INSPECTION PLANNING AND MEASURING

Description:

Given a print, students make out process sheet, identify inspection points in operations, and answer the questions of who, how, where, and why. Students do the planning work of an inspection team deciding what type of inspection programs new parts will receive.

Rationale:

Inspection is too often a "top-down" effort. One way to promote worker understanding and commitment is to involve workers in developing an inspection program.

Outcomes:

Upon completion of this activity, student will be able to:

1. Define the role of inspection.
2. Identify and describe incoming, ongoing, and final inspections.
3. Give advantages of early detection inspection.
4. List five things a worker at a company with a good inspection program will know.
5. Name two things checked in first-time inspections.
6. Identify central and on-floor inspection stations.
7. Given new parts, develop an inspection program from the receiving door to the shipping door for each part.

Tools, Materials, Machines, and Resources:

1. Automated manufacturing. (1987). Springfield, IL: Illinois State Board of Education. (Units 197-199)
2. Fergendaum. (1983). Total quality control. New York: McGraw-Hill Publishing Co. (pp. 254-258)
3. Juran, J. (Ed.). (1978). Quality control handbook (3rd ed.). Dearborn, MI: Society of Manufacturing Engineers.

Instructional Strategy:

Instructor introduces topic with lecture/discussion using oral questioning to check understanding. Students read information sheet and complete learning check sheet. Teacher should walk students through developing an inspection program for a part prior to group activity.

Safe Practices:

Many inspectors have been injured because they gave more attention to inspection than safety. Inspecting safely must be a top priority and kept in mind at all times.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Inspection evaluates materials, parts/assemblies, processes, and workmanship before, during, and after production. Evaluation includes measuring, checking, testing, assessing, and grading. The term **quality control** (QC) is used for overall company programs which prevent, detect, and recommend corrections for defects. Inspection primarily refers to the detection aspect of QC.

Although inspection efforts center on evaluating finalized parts, companies do many things before and during production to detect defects in materials and processes. Early detection saves money. Also, it eliminates wasted shop time and worker effort on parts which are scrapped or reworked. Returning or scrapping defective raw materials is much less expensive than scrapping finished products. Detecting production problems, such as machine errors, bad measuring tools, and faulty workmanship, ensures fewer rejects in final inspection.

Companies with good inspection programs have developed and defined these programs. Workers know what will be inspected, as well as how, when, why, where, and by whom. Inspectors are highly trained personnel with well defined jobs. They are not vaguely searching like policemen on patrol. Inspectors work from a logical check list which focuses on specific product characteristics or production aspects.

The three phases of inspection are incoming, in-process, and final. Too often workers overemphasize final inspection. True, defective products must be detected before reaching customers, but early detection saves money and effort. Companies buy raw materials and component parts from outside suppliers. **Incoming** inspectors must determine the quality of these materials and look for any flaws. Besides visual inspection, raw materials are measured and tested for specified characteristics. Inspectors test materials for chemical composition, hardness, strength, size, and other properties. The workers inspecting incoming materials might be QC personnel or trained receiving personnel.

In-process inspection examines the processing operations to ensure the quality production of parts/assemblies. Inspectors measure parts at different machining points. Machines are tested for set-up, accuracy and output quality. Workers are observed for craftsmanship and concern for quality. A critical time for in-process QC occurs in first-piece inspection of new products.

First-piece inspections test for part flaws and process errors in tooling or setup. Inspection personnel work with production and manufacturing personnel in a team effort to correct problems and prevent defective parts prior to the production run.

Inspectors check on many processes during in-process inspections. They inspect layouts, measure parts during machining, test partial assemblies, and examine finishing processes. Many times the actual production workers perform these inspections, with only occasional checks by actual inspection personnel. Some factories inspect sample parts from the line in special inspection rooms or areas. This is called **central inspection**, while other plants have **on-floor inspections** performed on the parts during processing.

The importance of in-process inspection depends on the product. Products like helicopter transmissions and precision CNC mills require every part to be inspected prior to assembly. Other products like light bulbs and paper cups will have only a few of every hundred inspected. Inspection often involves methods of sampling parts and statistically sampling measurements.

Final inspection examines finished products. Errors discovered in final inspection result in scrapped or reworked parts. Profit-conscious supervisors monitor these results closely. Final rejects have a cause somewhere between the receiving dock and the end of the production line. Any increase in "bad products" causes inspection personnel to search for "why."

Inspection, like all critical tasks, must be well defined and assigned. Many ways exist for companies to make workers responsible for inspection. Some assign the tasks to floor workers, others prefer specialized inspectors. Inspectors might follow a product from start to finish in one plant, in another they might be assigned to inspect one production process.

Automated manufacturing processes are increasingly replacing manual operations with machines. Production inspection easily changes from manual to automated examination using computerized vision machines, laser optics, and coordinate measuring machines. Machines inspect more accurately, faster, record, and make fewer mistakes than do human inspectors.

Learning Check Sheet: Layinsp.006

Complete the following:

1. Define inspection.

2. What is quality control?

3. What does early detection save?

4. What does early detection eliminate?

5. What five things do workers in a good inspection program know?

   A.
   B.
   C.
   D.
   E.

6. List the three phases of inspection.

   A.
   B.
   C.

7. List three material properties in-coming inspectors might test.

   A.
   B.
   C.

8. What two things are tested in first-time inspections?

   A.
   B.

9. What are the two terms used to describe the location of inspection stations?

   A.
   B.

Learning Check Sheet Answer Key: Layinsp.006

1. Inspection evaluates materials, parts/assemblies, processes, and workmanship before, during, and after production.

2. Quality control is an overall company program which prevents, detects, and recommends corrections for defects.

3. Money

4. Wasted shop time and worker effort on parts

5. A. What
   B. When
   C. Where
   D. How
   E. Why

6. A logical checklist which focuses on specific product characteristics or production aspects.

7. A. In-coming
   B. In-receiving
   C. Final

8. A. Chemical properties
   B. Hardness
   C. Strength of materials

9. A. Part or product flaws
   B. Process errors in tooling or setup

10. A. Central inspection
    B. On-floor inspection

Student Activity Sheet: Layinsp.006

In this activity, your team will develop an inspection program for two parts made for the first time by a company. This inspection program starts at the receiving door and ends on crates at the shipping door. You will act as part of a quality control team assigned the job of outlining inspection procedures for these two parts. Your instructor will assign your team the task of outlining an inspection program for given parts. Your team will develop an **on-floor** inspection program.

This activity suggests two parts, but these lack prints. The instructor may provide prints of two parts. This improves the realism, and, if time allows, you could actually make the parts and inspect them rather than making this a "think-through" activity. One part should be something like a small engine crankshaft. Blank (unfinished) casted cranks arrive via truck from a foundry. They require 100% inspection, need only a couple of machining procedures and a rust preventive finish before shipping to the assembly plant. The other suggested part, an air shroud for a small engine, gets stamped from sheet metal, spot welded, and a primer coat before shipping. It does not need 100% inspection. Your team has to decide what percentage to inspect.

Steps for activity:

Step 1. Your instructor assigns teams parts or gives prints for parts to be constructed as part of this activity.

Step 2. List operations to be performed on each part as it moves from receiving door to shipping door. For listing, use a familiar form such as a flow chart, operation process sheet, or work order.

Step 3. Outline inspection program for each part. Program includes:

- Identifying each operation, where and when, an inspection takes place.
- Explaining what to inspect at each inspection.
- Identifying who makes each inspection.
- Listing inspection devices and explaining how they are to be used in each inspection.
- Listing inspection procedures.

Step 4. (Optional): Class does production run of parts. Prior to production run, class discusses the inspection outlines proposed by teams, and decides on which one to use for the actual production.

Alternative Strategies for Activity Number: Layinsp.006

Inspection is something most students do not fully appreciate until seeing the importance given to quality by companies. If students are taken on a field trip to a plant with a thorough quality control program, they should be given a question sheet requiring very short answers during the tour. The questions would focus students' attention on the important role of quality, as well as basic inspection techniques.

Learning/Performance Checks: Layinsp.006

Instructor assesses learning with responses on learning check sheet and written work developed during activity. Particular attention is given to clarity and correctness of inspection procedures in activity.

Student performance is evaluated based upon participation and initiative in activity. If teacher elects to actually make parts for inspection, student should be graded on actual lab portion of activity.

ACTIVITY NUMBER LAYINSP.007

INSPECTION ETHICS

Description:

In this activity, students consider situations inspectors might encounter where ethical questions might be an issue. Students must make ethical decisions regarding possible product or process problems detected in their jobs.

Rationale:

Ethical questions often arise in the workplace. Considering possible situations ahead of time awakens and develops a student's ethical reasoning. Few ethical problems are simple "black-and-white" issues. Most are multifaceted, requiring students to make multiple considerations before choosing a course of action.

Outcomes:

Upon completion of this activity. student will be able to:

1. Define ethics.
2. List four primary viewpoints from which people make moral judgments.
3. List four factors influencing workplace ethical decisions.
4. Describe how the relationships of inspectors and others in the workplace influence ethical inspection decisions.

Tools, Materials, Machines, and Resources:

1. Any newspaper or magazine articles relating to ethical questions about inspection.

Instructional Strategy:

Instructor introduces the topic of business ethics faced by inspectors with reading assignments and guided lecture to clarify topic prior to discussion. A focused discussion with relevant examples and leading questions will help student understanding and generate thinking before activity. Student thinking should be encouraged in activity, not absolute right or wrong answers.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications____________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Student Information Sheet Number: Layinsp.007

Ethics are individual or social codes of conduct which guide people's decisions of right or wrong behavior. People often interchange the term **moral** for **ethics**. Human beings arrive at moral judgments from four primary viewpoints: religious, humanitarian, legal, and social. Religious teachings use divine commandments to guide moral decisions. Humanitarian reasons for ethical actions are determined by one's view of how a "good" person should act. A legal viewpoint establishes behavior in accordance with laws. Socially based actions are those acceptable to society.

Whenever humans interact, ethical questions will arise. Frequently, individuals encounter ethical problems in business or at the workplace. Ethical judgments must be made regarding company dedication, money, promotions, work performance, co-workers, safety, customers, and so on.

A multitude of factors in the workplace influence ethical decisions.

At home, in church, or at social events, individuals are likely to make moral decisions based on religious, humanitarian, or social beliefs. The workplace adds the influences of others including customers, employers, supervisors, co-workers, and employee attitudes. Because of the complexity of business ethics, people often consider them with a different set of standards.

One faces many ethical considerations in business. Honesty should exist in transactions among businesses, and also between businesses and consumers, employer/employees, companies and government, and co-workers. Honesty covers many things including false advertising, stealing, defrauding, trustworthiness, and lying. Product and plant safety issues are highly ethical with life, health, and property at stake. Environmental issues become ethical when businesses pollute their surroundings, which infringe on nature, as well as the health and property of others.

An inspector's role causes him/her to encounter numerous situations in business ethics. Most inspectors are in precarious positions. They are paid by an employer, directed by a supervisor to ensure that co-workers produce customer-satisfying products which meet government and private agency approval. Inspectors sometimes find themselves in the middle of many conflicting parties. To avoid co-worker and employer influences over inspectors, some companies and agencies hire independent inspectors.

Employers hire inspectors to detect product or process problems. These problems could be in specifications, quality, or safety. In the long run, rejecting parts saves in returns, recalls, and reputation. In the short run, rejecting parts costs in scrap, rework, and lost labor. A "too-picky" inspector causes unnecessary losses. A "let-it-slide" inspector defeats the company's purposes for quality control. A major problem for inspectors and employers is deciding what constitutes a reject. Businesses must make a profit to exist. Whether a business' main concern is short run or long run, profit influences the "pickiness" of inspectors.

Inspectors work immediately under a supervisor, whose main concern is running a smooth and efficient department. Supervisors are guided by both company policy and desire to do a good job. This desire could be quality inspections or maximum profits. Inspectors must satisfy supervisors, so a supervisor's viewpoint influences the inspector.

Work rejected by inspectors often upsets co-workers, especially the operator responsible for the part. Inspectors sometimes have to decide whether to do their job correctly or to get along with co-workers. Floor workers tend to have short-run attitudes. For this reason, many companies try to sell workers on building quality into products. An example of this is Ford's company-wide campaign, "Quality is Job One."

Learning Check Sheet: Layinsp.007

Answer the following:

1. Define ethics.

2. List four viewpoints from which human beings arrive at ethical decisions.

   A.
   B.
   C.
   D.

3. Give four factors which influence ethical decisions in the workplace.

   A.
   B.
   C.
   D.

4. Describe the precarious position most inspectors are in.

5. What are three "long-run" savings from inspection rejects?

   A.
   B.
   C.

6. What are three "short-run" costs from inspection rejects?

   A.
   B.
   C.

7. What is a major problem for inspectors and employers?

8. What is the main concern of an inspection supervisor?

9. What main concern of business influences the "pickiness" of inspection?

10. Floor workers tend to have what kind of inspection attitude?

Learning Check Sheet Answer Key: Layinsp.007

1. Ethics are individual or social codes of conduct which guide people's decisions of right or wrong behavior.

2. A. Religious
   B. Humanitarian
   C. Legal
   D. Social

3. Choose from, but do not limit, answers to four of the following:

   A. Company dedication
   B. Employer
   C. Customers
   D. Money
   E. Promotions
   F. Work performance
   G. Safety
   H. Supervisors

4. They are paid by an employer, commanded by a supervisor to ensure that co-workers produce customer-satisfying products which meet government and private agency standards.

5. A. Returns
   B. Recalls
   C. Reputation

6. A. Scrap
   B. Rework
   C. Lost labor

7. Determining what constitutes a reject

8. Running a smooth and efficient department

9. Long-term or short-term profit

10. Short-term

Student Activity Sheet: Layinsp.007

Your instructor will assign you to a small group which will discuss and write down responses to the following inspection situations. For all situations, your group will consider themselves to be company inspectors. Each team will make a decision on how they would respond to each question, and write 3-5 sentences in support of the decision.

Situations:

#1. While inspecting large wheel bearings assemblies for trucks and buses, you find 5 of every 100 roller bearings have defective heat treating, which could cause early failure from wear. You tell your supervisor. He has the heat treating problem corrected, but does nothing to find how many bad bearings went out over the past week. When you confront him, his response is that most of the bearings will last past the manufacturer's warrantee, so don't worry about it. If your calculations are right, the hardness problem will cause around 1,000 bearing failures in the next year.

Read the above situation, answer the following:

1. Is this an honesty or a safety issue?
2. What are your options as an inspector?
3. List two factors influencing the supervisor's decision.

   A.
   B.

#2. You inspect at the receiving dock for a lawn mower manufacturer. A shipment of sheet metal arrives which has a poor finish on one side. The company buyer gets the supplier to sell the material as blemished for one-third the original price. The seller reduced the price, understanding the material would be used on inexpensive lawn mower parts. Seeing a chance to boost quarterly profits, the production supervisor uses the sheet metal on the expensive lawn mower line. He simply turned the bad side toward the mower blade.

1. Are there any ethical problems with the production supervisor's decision?
2. Would the production supervisor's decision be dishonest to anyone?
3. What are your options as an inspector?

#3. You are an inspector at a plastics plant which makes housings for electronic equipment and computers. A machine operator, who you are also dating, does a poor job of setup and machine adjusting. Your supervisor noticed an unusually high number of rejects in the past quarterly report. He instructs you to find the machine operator causing the bad parts.

1. Is there any ethical problem here before making your report to your supervisor?

2. What are your options as an inspector?

#4. As an inspector at a chemical plant making paint for military equipment, you discover the production department substituting cheaper chemicals in the formula. The plant manager offers to give you a company car to forget what you know.

1. Who is being cheated in this situation?

2. What are your options as an inspector?

3. If you accept the car, are you as guilty as the plant manager?

#5. The company you inspect for makes brake parts for auto makers. Trying to compete with foreign parts suppliers, it has cut as many costs as possible, resulting in increased problems in quality. Your company's largest customer warned that the next problem will cause a contract cancellation. You discover an intermittent problem with a one-month-old machine making brake springs. If all the springs made in the past month are recalled, contracts will be lost, and the plant will shut down putting 300 people out of work--you included. If the springs are not recalled, some springs will break, causing brake problems.

1. What parties are involved in the ethical problem here?

2. What are your options as an inspector?

#6. After working 15 years at a machine tool manufacturing plant, you have become the top inspector. Recently, the inspection supervisor's job came open and you were passed over for promotion. The company froze wages last year and this year they cut pay for hourly employees by 5%. During the same period, managerial salaries went up 10%. Your company sends you to another factory to learn about an automated inspection system which could save your company money and do a better job with half as many inspectors. The automated system is just what your company needs and you have to make out a report on whether or not to buy one.

1. Is it ethical to recommend your company not buy the automated system?
2. Do you consider what the company did to you a matter of ethics or just business?

Alternative Strategies for Activity Number: Layinsp.007

Activity 1:

Directions: Below are short descriptions of inspection situations. Read each situation, then choose a course of action. Be prepared to explain your reasoning. You are an inspector in each situation.

1. Your factory makes products on piecework. They started making a new product which is more difficult to inspect. You cannot keep up with the quota and have told your supervisor who won't listen.
2. You discover inferior material being used in the saw blades produced by your company. When informed, the production supervisor says he knows, but this order is going to Third-World countries who want cheap saw blades, not quality ones.
3. The marketing department put together an advertising brochure for the lamps made in your factory. Upon reading it, you find the quality of materials has been exaggerated. Your notify the vice-president of marketing who tells you the brochure is accurate enough and legal, so he'll worry about his job and you worry about yours.
4. You get transferred from inspecting assemblies to machining inspection. You soon discover the machinist build parts with too much precision. Time is wasted with extra machining. In the lunch room, you mention this to some of the machinists. They reply with, "Quality comes before quantity." At home that night, you get an anonymous call warning you not to change machining practices or else accidents might start to happen.
5. You learn that a fellow inspector, a friend of yours, occasionally fails good products. All failed products are put in the scrap bin, but someone takes the good ones out at night before the scrap truck arrives in the morning.

Activity 2:

Instructor saves articles relating to problems with product quality. Class discusses how an inspector might have prevented the problem. Students determine if any ethical questions are involved in the situations. If ethical questions are present, what are the causes and solutions?

Learning/Performance Checks: Layinsp.007

Instructor evaluates learning by student responses to Learning Check Sheet and written work in team problem solving activity.

Student performance is based on effort, time on task, and attention to details in the problem solving activity.

ACTIVITY NUMBER LAYINSP.008

AUTOMATED INSPECTION PROCESSES

Description:

Students simulate automated inspection processes.

Rationale:

Automated inspection processes are quickly replacing manual inspections because they are faster, more reliable, process more product information, and can be integrated with other processes. Workers need to understand the basics of computer automated inspection and how they affect manufacturing.

Outcomes:

Upon completion of this unit, student will be able to:

1. Identify and describe automated inspection processes.
2. List three new technologies which have caused advances in automated inspection.
3. List four tasks done by computer integrated automated inspection systems.
4. List four limitations of automated inspection systems.
5. Given a production processes diagram, propose and sketch out automated inspection systems.
6. Construct a model of an automated inspection system.

Tools, Materials, Machines, and Resources:

1. Pryor, T. (Ed.). Applying automated inspection. (1985). Dearborn, MI: Society of Manufacturing.
2. Automated Inspection/Non-Destructive Testing (Video explains automated inspection and nondestructive tests used in manufacturing). (1989). Dearborn, MI: Society of Manufacturing Engineers.

3. Machine Vision (Video concentrates on five uses of vision to improve quality at a GM plant). (1985). Dearborn, MI: Society of Manufacturing Engineers.

4. Periodicals, textbooks, brochures, technical manuals, etc. for student resources.

5. Graph paper for making production processes diagrams or instructor-provided diagrams.

Instructional Strategy:

Instructor introduces topic with lecture/discussion of inspection fundamentals. The evolution and advantages of automated inspection processes should be emphasized. When available, topic introduction should be supplemented with audiovisual materials. Students read information sheet and complete learning check sheet. Teacher should review good modeling techniques and reinforce these during activity. Students should be encouraged to be inventive in their models, without too much time-consuming elaboration. Components which actually move always are more realistic.

Safe Practices:

While working in shop, all safety rules should be followed. Safety should be a major consideration in the design and arrangement of an automated inspection station.

Integrative Skills

Communication:

x Reading
x Writing
x Speaking
x Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

x Assertiveness
x Negotiation
x Listening
x Risk Taking

Change:

_____ Personal Adaption
x Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_______________________________

Decision Making:

_____ Ethical Reasoning
x Logical Reasoning
x Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

During the '60s and '70s, many American manufacturers skimped on quality to keep product costs down. Consumers found that inferior products were no bargain. In the '80s, buyers considered both quality and cost. The result: American consumption of higher quality, less expensive overseas goods went up drastically. American companies responded by improving product quality. Some ways to improve quality include using better materials, improving manufacturing processes, enhancing design, and inspecting more accurately. Manufacturers have concentrated quality control efforts on inspection.

Coinciding with the increased importance of quality has been the growth of automated manufacturing processes. Both are transforming the appearance of American factories from dirty, laborious lines of manned machines to clean, self-operating machines. Increasingly, firms rely on automatic machines to do the work of handling, machining, and inspecting. New technologies in microcomputers, controls, and sensor systems have caused the advances in automation.

Automated inspection accompanies automated machining operations. Fully computer automated production operations are known as computer integrated manufacturing (CIM). Computerized inspection devices have sensors which identify products, measure sizes, locate parts, and check for missing or misplaced components. Sensors are in fixed positions; others move along coordinate measuring axes. Moving sensors, known as probes, may or may not contact the part. Like its human counterpart, some computerized inspectors are capable of examining multiple items on one part and making decisions, except the computers do it faster, more accurately, without fatigue, more reliably, and record information better. These stored data are an essential element for statistical product control (SPC). Besides assessing quality, other uses for this data include controlling operations, tracking, and inventory.

A variety of automated inspection systems exist including vision, coordinate measuring machines (CMM), lasers, and automatic gauging. Some are dedicated to one type of inspection; others have flexibility. A vision inspection device uses a camera to view illuminated parts, and then a computer to process the image data. Illumination sources include lasers, infrared, and plain light. Different types of cameras are the sensory devices. This information is processed inside a computerized image processor. The processor reads some images as codes or words. Other times, the processor analyzes data gathered from triangular geometry, two-dimensional edges and areas, and the degrees of grey.

CMMs inspect features sizes and locations by using probes to sense surface points. These data are used to check for tolerances, SPC, reverse designing, record keeping, and process adjustments. The variety of uses for lasers grows as laser technology evolves. Lasers read labels, examine size and location, and check alignments. Automated gaging works on the same principles as does manual gauging; some make adjustable measurements, while others compare feature sizes to fixed gauges.

Most mass-produced products lend themselves to computer automated inspection. Labels are read and verified. The placements of container tops are checked. Feature sizes and locations are inspected. Automated inspection confirms the correct placement of specified components.

Although a great boost to manufacturing, automated inspection systems have limitations. They have limited flexibility, are expensive, require expensive maintenance, and are quickly being replaced by less expensive and better technology.

Learning Check Sheet: Layinsp.008

Complete the following:

1. What did American manufacturers do during the '60s and '70s to keep product costs down?

2. In the '80s, what two things do buyers consider?

   A.
   B.

3. Give two reasons American buyers started purchasing overseas goods.

   A.
   B.

4. List four ways to improve quality.

   A.
   B.
   C.
   D.

5. List three new technologies which have caused advances in automation.

   A.
   B.
   C.

6. What is the term for fully computer automated production?

7. What are four things computerized inspection devices can do?

   A.
   B.
   C.
   D.

8. List four types of automated inspection systems.

   A.
   B.
   C.
   D.

9. Give five uses of CMM data.

   A.
   B.
   C.
   D.
   E.

10. What are four limitations of automated inspection systems?

    A.
    B.
    C.
    D.

Learning Check Sheet Answer Key: Layinsp.008

1. Skimped on quality

2. Quality and costs

3. A. Lower cost
   B. Higher quality

4. A. Better materials
   B. Improving manufacturing processes
   C. Enhancing design
   D. More accurate inspection

5. A. Microcomputers
   B. Controls
   C. Sensor systems

6. Computer integrated manufacturing

7. A. Identify parts
   B. Measure sizes
   C. Locate parts
   D. Check for missing or misplaced components

8. A. Vision systems
   B. CMM
   C. Lasers
   D. Automatic gauging

9. A. Check for tolerances
   B. SPC
   C. Reverse designing
   D. Record keeping
   E. Process adjustments

10. A. Limited flexibility
    B. Expensive
    C. Require expensive maintenance
    D. Quickly being replaced by less expensive and better technology

Student Activity Sheet: Layinsp.008

In this activity, you will develop an understanding of automated inspection processes through guided self-learning. Manufacturing workers are exposed to various types of inspection.

In order to demonstrate an understanding of automated inspection processes, you will build a model of an automated inspection device. The model should be about the size of a desk top. The model should include an actual part that is being inspected.

The instructor will select parts which use automated manufacturing processes familiar to your class. Emphasis should be placed on learning about automated inspection.

You will build neat, labeled, and very basic models. The major components must be included, but minor details can be left out. Construction materials may be whatever is handy--paper, cardboard, plastic, wood, metals, etc. If models are to be displayed as projects, better materials, closer likenesses to machines, and more precision machining should be stressed.

Your teams will be assigned one of the automated inspection processes to use in your model. In order to make a model of the components, you must research an inspection process. This includes explaining the process and describing components. Write up a narrative for your team's model, which will be displayed with it. The model will also be presented with explanations to the class.

Procedures for Activity:

Step 1: Instructor assigns your team parts/prints and automated inspection process for model.

Step 2: Research assigned inspection process. Develop a bibliography of your sources including videos, textbooks, brochures, technical manuals, and manufacturing periodicals.

Step 3. Develop a flow process chart and flow diagram of shop layout. Indicate where in the chart and on the diagram the automated inspection process would take place.

Step 4. Write up a rough draft description describing their inspection process. Instructor checks and approves these for content.

Step 5. Make sketches of models to be built. Instructor approves models for accuracy. Models should be uncomplicated because of time constraints.

Step 6. Construct models.

Step 7. Models are presented to the class. Teams explain their assigned processes and describe components of their automated inspection systems.

Alternative Strategies for Activity Number: Layinsp.008

Students could learn from simulating automated inspection processes, but benefit little compared to time and efforts. Other methods of exposure would do a better job of meeting the same goals, with less time and effort. Quality control videos or videos on particular inspection processes are excellent means of informing students about the types of automated inspection.

A guest speaker from an automated quality control department is a good source for alerting students to types of automated inspection. Prior to the speaker, instructor should introduce the topic with reading, lectures, and available audiovisual materials.

Learning/Performance Checks: Layinsp.008

Instructor checks for student learning using Learning Check Sheet, written outline, and explanation for activity, and oral questioning. Class presentation of model and automated inspection process best demonstrates student learning.

Evaluation of student performance is based on student effort and participation in activity. Emphasis should be placed on the quality and correctness of the work.

OCCUPATIONAL SAFETY AND HEALTH

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UNIT GOALS 4

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SAFETY.001 **Machine Guarding** 6

Learners study some types of barrier guards used to eliminate contact with cutters or pinch points. After studying several examples, learners are given a guarding problem. Their solution should demonstrate the basics of effective guarding.

SAFETY.002 **Stock Control** 12

Learners study some methods of stock control that keep hands clear of the danger zone, pinch point, or cutter. Students learn about jigs and fixtures that control stock or tools and describe how these devices make the job safer. Learners are then given a jig or fixture design problem. Their solution should demonstrate the basics of effective stock control.

SAFETY.003 **Safety in an Automated Environment** 17

Learners study safety in an automated environment (robotic work cells) and discuss some hazards associated with working on, in, or near automated equipment.

SAFETY.004 **Chemical Hazards in the Workplace** 23

Students learn about chemical hazards in the workplace and study methods of recognizing, avoiding, and controlling chemical hazards. Students will also learn about the Material Safety Data Sheet which is an OSHA regulation concerned with an employee's right to know about workplace hazards.

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UNIT GOALS

Upon successful completion of this unit, the learner will be able to:

1. Recognize unsafe machine practices related to forming, separating, and combining processes. (Safety.001, .002, .007)

2. Demonstrate a safe attitude in the manufacturing environment. (Safety.001, .003, .007)

3. Trace the history of occupational safety and health in the United States, citing important events and trends. (Safety.004)

4. Name and describe safety and health-related legislation or regulatory agencies that control industrial operations in the United States. (Safety.004)

5. List the real and hidden costs of an accident and discuss their impact on profit and morale. (Safety.009)

6. Describe the elements of an accident investigation and discuss the purpose and significance of conducting an accident investigation. (Safety.009)

7. Name and describe fire hazards in our environment and discuss methods of eliminating and controlling them. (Safety.006)

8. Explain the manufacturer's responsibility for product liability and discuss the consequences or a poorly made or designed product. (Safety.012, .013)

9. Apply basic communication skills to accident reports, safety checks, and safety inspections. (Safety.008)

10. Evaluate tools, materials, jigs, and fixtures for safety and fitness. Make recommendations to eliminate unsafe conditions. (Safety.001, .002, .003)

11. Describe ways in which manufacturing influences our environment. Make recommendations for improving the environment. (Safety.005)

12. Use basic communication skills to develop safety rules/guidelines for a machine, power tool, or handtool. (Safety.008)

13. Review accident statistics and identify trends in industrial accident prevention. (Safety.009)

14. Define "ergonomics" and discuss its impact on machine design and accident prevention. (Safety.010, .011)

GOALS
(continued)

15. Define product liability and list issues concerned with safety and product liability. (Safety.012, .013)

16. Discuss the importance of personal protective equipment and describe various types of personal protective equipment. (Safety.014)

ACTIVITY NUMBER SAFETY.001

MACHINE GUARDING

Description:

Learners study some types of barrier guards used to eliminate contact with cutters or pinch points. After studying several examples, learners are given a guarding problem. Their solution should demonstrate the basics of effective guarding. Students or instructor bring in illustrations of guards used in automated environments or other manufacturing environments.

Rationale:

Understanding how guards can contribute to safe working conditions will develop an acceptance and respect for guarding.

Outcomes:

Students will list ways in which guards contribute to a safe working environment and discuss the importance of guarding as a way to eliminate hazards in the workplace. Students will also discuss the dangers involved when performing operations without guards.

Tools, Materials, Machines, and Resources:

1. Strong, Merle E. (Ed.). (1975). Accident prevention manual for training programs. Chicago: American Technical Publishers, 1975. (ISBN 0-8269-4517-1)
2. Supervisor's safety manual. (1973). Chicago: National Safety Council. (ISBN 0-87912-061-4)
3. Some examples of good/effective guards on various tools or machines.
4. Materials to make a mock-up or prototype guard.

Instructional Strategy:

The instructor provides an overview of the types of injuries that can occur when guards are not used. Through lecture, demonstration or slides, the instructor provides some examples of effective guarding. The students are then divided into groups and given a guard design problem. Student groups sketch some solutions and evaluate them. Each group then makes a mock-up guard out of cardboard or other material. If the solution is feasible, students can make a wood, metal, or plastic prototype for evaluation.

Student groups compare their solutions to learn from each other. Groups also bring in illustrations of guards used in other manufacturing applications.

This safety unit may be integrated with a manufacturing unit if an application of guarding principles can be implemented. If students can see a direct application, the value of the lesson increases.

Safe Practices:

When working with tools or machinery, be sure they are disconnected from the power source. Guarding prototypes should be evaluated by an instructor or expert in the field.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

A guard is a device that acts as a barrier between the operator and a dangerous element of a tool or machine. Guards are usually made of metal or plastic, but other materials such as wood may also be used. Guards may also control the workpiece in some manner. For example, the guard may keep the work on the table of the tool or keep the work against the fence of the tool. Some guards have an anti-kickback device incorporated into their design. An anti-kickback device keeps the work from being ejected from the machine during the machining operation.

Guards keep your hands away from nip points and sharp cutters. For example, the guards on the table saw and milling machine keep you from contacting the sharp blade or cutter. Nip points are found in places where your hand could get caught between two in-running objects. A good example of a nip point is the point between a belt and a pulley. These are usually found between the machine and its drive motor.

Guards sometimes keep you away from other hazards such as heat, steam, or dangerous pressures. These types of guards are found on plastic molding machines, air compressors, and steam generators. As you look around your environment, you will find many types of guards. Make note of them; you may be able to apply their design to other guarding problems in your environment.

Name________________________________ Class____________ Date______

Questions for Discussion

1. How would you define "guard"?

2. What is the function of a guard?

3. What materials are used to fabricate guards?

4. From what type of hazards do guards protect us?

Alternative Strategies for Activity Number: Safety.001

Instructor can point out guards on various tools or machines as they are discussed or demonstrated. A field trip to a manufacturing facility can be used as an example of guarding applications.

Students can check guards in the lab for working properties and good working order.

Learning/Performance Checks: Safety.001

Class contribution toward guard design and mock-up fabrication can serve as a performance check.

Participation in the guard lecture and demonstration will check learning.

Responses to the questions on Machine Guarding will demonstrate an understanding of the function of guarding.

ACTIVITY NUMBER SAFETY.002

STOCK CONTROL

Description:

Learners study some methods of stock control that keep hands clear of the danger zone, pinch point, or cutter. Students learn about jigs and fixtures that control stock or tools and discover how these devices make the job safer. Learners are then given a jig or fixture design problem. Their solution should demonstrate the basics of effective stock control.

Rationale:

Understanding how stock control can contribute to the safety of an operation will develop an acceptance of stock control and a willingness to incorporate it into future projects.

Outcomes:

Learners will be able to define stock control and discuss its importance as a means of eliminating unsafe conditions around machinery. Learners will be able to list methods which may be employed to control stock safely when performing industrial operations.

Tools, Materials, Machines, and Resources:

1. Cliffe, Roger W. (1981). *Woodworking principles and practices*. Chicago: American Technical Publishers.
2. Strong, Merle E. (Ed). (1975). *Accident prevention manual for training programs*. Chicago: American Technical Publishers. (ISBN 0-8269-4517-1)
3. *Supervisor's safety manual*. Chicago: National Safety Council, 1973. (ISBN 0-87912-061-4)
4. Some examples of stock feeding devices such as feed tables or power feeders. Stock control devices such as metal holddowns or featherboards. Some examples of jigs and fixtures that were designed to make a job or operation safer through stock control.

Instructional Strategy:

Instructor provides an overview of the types of injuries that can occur when stock control devices are not used. Through lecture, demonstration, or slides, the instructor provides some examples of effective stock control. The students are then divided into groups and given a stock control problem. The students sketch some solutions to the problem based on the examples they have seen. If the design is needed for a production project, students build or set up the necessary stock control devices.

This safety unit may be integrated with a manufacturing unit if an application of stock control principles can be implemented. If students can see a direct application, the value of the lesson increases.

Safe Practices:

When working with tools or machinery, be sure they are disconnected from the power source. Instructor should provide safety information related to tool or machine as needed.

Integrative Skills

Communication:

_____ Reading
_____ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Student Information Sheet Number: Safety.002

CONTROLLING STOCK IN MANUFACTURING OPERATIONS

When you work on any object, it is important to have control over that object while you shape, cut, form or otherwise work on it. This is known as stock control. Two very common methods of controlling stock are vises and clamps. Stock control allows you to keep your hands clear of cutting tools or other hazards while you work.

Many power tools have power feeders to control stock. Others require hand feed, but provide fences, gauges or other surfaces on which the work may ride. You may use push sticks or other feeding devices to control stock. A push stick is a device that can be used to hold stock that passes near a bit or cutter. It gives your hands a margin of safety.

Some metalworking machines use a vise to control the stock. The vise is moved by a threaded rod. As the feed handle is cranked, the vise moves the work into the cutter. This allows the operator to keep his/her hands clear of the cutter and danger zone. It also provides greater control of the work. A vise has more power than hand strength.

Some machines use featherboards, spring holddowns, or other devices to help control stock that is being hand fed. These devices hold the work against the table or fence while the work is being hand fed. A push stick may be used with other stock control devices. The push stick keeps your hands out of the danger zone while the operation is being performed.

Alternative Strategies for Activity Number: Safety.002

Instructor can point out stock control devices on various tools and machines as they are discussed or demonstrated. Students can list all control devices in the shop/lab and cite one advantage and disadvantage of each.

Learning/Performance Checks: Safety.002

Class contribution during the discussion of power feed/stock control devices will check learning.

Group participation in the power feed design problem will also demonstrate learning.

ACTIVITY NUMBER SAFETY.003

SAFETY IN AN AUTOMATED ENVIRONMENT

Description:

Learners study safety in an automated environment (robotic work cells) and discuss some hazards associated with working on, in, or near automated equipment.

Rationale:

Automated industrial operations present unique hazards since people working near this equipment may not be able to stop an operation if an accident occurs.

Outcomes:

Learners will be able to list and describe hazards that exist in an automated environment and discuss methods of avoiding these hazards.

Tools, Materials, Machines, and Resources:

1. Robots: Selection and Installation (videotape). Bergwall Productions, 106 Charles Lindbergh Blvd., Uniondale, NY 11553-3695.

2. Video player and monitor.

3. Table-top automation model.

Instructional Strategy:

The instructor provides some examples of hazards in the automated environment and shows the learner how the hazards differ from those in a nonautomated environment. These may be demonstrated on the table-top automation equipment. The learners view the videotapes to learn more about the automated environment. After viewing, the learners are divided into groups to develop rules or generalities concerning safe work habits in the automated environment. Each group reports its findings to the class and a master set of rules or generalities are developed.

Safe Practices:

During any demonstration, all students should be wearing appropriate protective equipment.

Integrative Skills

Communication:

_____ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

When working around automated manufacturing equipment, there are two concerns. The first concern is worker safety. Industrial accidents cause down time due to personal injury. A person could incur a permanent injury that changes or reduces the quality of life. When an injured person is replaced, there is likely to be decreased production. Another concern is that of damaged equipment. Equipment must be maintained and operated according to the manufacturer's specifications. Failure to operate or maintain equipment properly could result in damaged equipment and down time. When equipment is down for repair, there is a decrease in production and profitability.

The Occupational Safety and Health Act (OSHA) of 1970 establishes guidelines for industrial safety. These guidelines include some safety requirements for working in an automated environment. The areas covered by OSHA include: materials handling, abrasive wheel machinery, mills and calendars, mechanical power presses, forging and welding, and cutting and brazing. Safe practices around automated manufacturing equipment include the following:

1. Protective glasses, goggles, or shields must be worn in the production area.
2. Protective clothing or accessories should be worn in areas where such attire is specified.
3. All personnel should know the location and use of emergency stop buttons or power panel for shutting down automated systems.
4. Personnel should be properly instructed on equipment operation and be conscious of unusual sounds, vibrations, or irregular operations.
5. Pinch points should be recognized and avoided.
6. Untrained or unauthorized personnel should not be permitted in the automated manufacturing area.
7. Maintenance and adjustments should only be performed by authorized personnel with proper training and should be performed according to manufacturer's specifications.
8. Safety zones and safety lines should be recognized and complied with.
9. Precautions should be taken around material handling systems (conveyors, lifts, etc.).

10. Precautions should be taken to avoid material transport vehicles (overhead cranes, robot carriers, etc.).

11. Working space in and around robots and within work cells should be kept clear of obstructions.

12. All personnel must have maximum respect for all automated equipment.

Safety for equipment must also be given adequate consideration. Proper installation and accessibility for maintenance and operation will help in keeping the automated system operating safely and efficiently. Lack of compliance may result in corrective action taken by employees in the form of grievances or legal action initiated by federal, state, or local agencies whose purpose is to monitor industrial safety. OSHA officials may also make periodic inspections of facilities to ensure safe operating conditions.

Alternative Strategies for Activity Number: Safety.003

If automated models or videos are not available, instructors should use real-life examples such as garage door openers and power windows in cars. Learners can discuss how these devices are made safe and how individuals must work around such devices.

Learning/Performance Checks: Safety.003

Student contributions during discussion should be an indicator of learning. A test could be written from the rules and generalizations developed by the student groups.

ACTIVITY NUMBER SAFETY.004

CHEMICAL HAZARDS IN THE WORKPLACE

Description:

Students will learn about chemical hazards in the workplace and study methods of recognizing, avoiding, and controlling chemical hazards. They will also learn about the Material Safety Data Sheet which is an OSHA regulation concerned with an employee's right to know about workplace hazards.

Rationale:

Chemical hazards have become a growing problem in the working and living environment. Student awareness of these hazards could be the first step in control of this hazard.

Outcomes:

Students will identify chemical hazards that exist in the workplace and list methods of recognizing, avoiding, and controlling these hazards. Students will define the term "OSHA" and discuss its legislation in the field of hazardous material safety.

Tools, Materials, Machines, and Resources:

1. Detection and Prevention (video available from Lab Safety Supply, P. O. Box 1368, Janesville, WI, 53547-1368; 1-800-356-0783).

2. Video player and monitor.

Instructional Strategy:

Students will watch the video and discuss chemical properties, toxicity, exposure, and dosage. After viewing, the students will learn about the Occupational Safety and Health Act (OSHA) and its legislation concerning hazard communication standards. Students will be able to discuss the impact this legislation has on the worker and the workplace.

Safe Practices:

Instructor provides safety materials for chemicals related to class activities.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Safety.004

The Occupational Safety and Health Act (OSHA) was signed into law in 1970. Its purpose was to "assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources." Since the start of OSHA, a series of standards and codes have been enacted to keep workers safe in the workplace. These codes can be broken into two distinct groups--safety, and health.

Safety codes refer to the safe operation of tools and equipment. These codes govern the types of tools that may be used on a job and the way they are guarded. These codes also dictate the way electrical wiring should be run and connected in the workplace. There are even codes that describe how a guard on a specific piece of equipment should be designed and built.

The health codes refer to hazards that would affect the health of the worker who is exposed to them in the course of doing his/her job. Many of these hazards do not seem obvious because they do not affect one's health quickly; they take months or years to affect a person's your health. One of the first health issues OSHA brought to light in the workplace was hearing loss. Persons who were exposed to loud noises in the workplace would lose a portion of their hearing over time. The louder the noise level of the workplace, the greater the hearing loss would be. Because of OSHA, many workplaces are quieter and more pleasant today.

As OSHA begins its third decade, the emphasis is on chemical hazards in the workplace. Many chemicals used in manufacturing have been found to cause cancer in humans. For this reason, OSHA has enacted the Hazard Communication Standard. The Hazard Communication Standard is a training program that tells workers about the chemicals with which they work. The information about chemicals in the workplace includes: its actual identity even if it has a trade name, the hazardous ingredients in the chemical, the physical and chemical characteristics, the physical hazards, and OSHA exposure limits.

As it becomes apparent to us that some chemicals in the workplace can give us cancer, does it make you wonder what damage may be caused by chemicals disposed of into the environment as a byproduct of manufacturing? Some of these chemicals can pollute our land and contaminate our water supply. What can we do to reduce the spread of these chemicals in our environment--both working and living?

Name_________________________________ Class_________ Date_____________

Our Safety and Health

1. What is OSHA, and what is its purpose?

2. What two aspects of the workplace are governed by OSHA?

3. The safety portion of OSHA legislation governs such things as...

4. The health aspect of OSHA legislation governs such things as...

5. As OSHA enters its third decade, what is the thrust of its legislation?

6. How does OSHA expect to enact its newest legislation?

7. Is there a legislative group that governs the environment outside the workplace? If so, is it enacting similar legislation?

Alternative Strategies for Activity Number: Safety.004

Students find a current events article on the impact of hazardous chemicals on the work or living environment. Students complete work sheet on Chemical Hazards in the Workplace.

Learning/Performance Checks: Safety.004

Completion of information sheet on Chemical Hazards in the Workplace indicates understanding of hazardous chemicals in the environment.

ACTIVITY NUMBER SAFETY.005

CHEMICAL SPILLS IN OUR ENVIRONMENT

Description:

Students learn about chemical spills in the environment and study their impact and clean-up costs. Students will make some judgements/decisions concerning the disposal of chemicals in our environment.

Rationale:

Chemical hazards have become a growing problem in the working and living environment. Student awareness of these hazards could be the first step in the control of this hazard.

Outcomes:

Students will be able to list the dangers of a chemical spill and describe the potential damage to our environment.

Tools, Materials, Machines, and Resources:

1. First on the Scene (videotape available from Lab Safety Supply, P. O. Box 1368, Janesville, WI, 53547-1368; 1-800-356-0783).
2. Video player and monitor.

Instructional Strategy:

Students watch the video and discuss some aspects of a chemical spill such as cost, hazards, danger to humans, danger to the environment, and liability for the clean-up. Students divide into groups, read the information sheet and respond to the discussion questions. If possible, some representative of the Environmental Protection Agency conducts a session on the proper disposal of household chemicals. Instructor tries to get a commitment for a change of behavior from each of his/her students.

Safe Practices:

Provide information concerning personal protective equipment related to chemical hazards.

Integrative Skills

Communication:

_____ Reading
_____ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
__x__ Listening
_____ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Chemicals are everywhere in our environment. We use chemicals to control insects, clean our clothes, remove other chemicals from our automobiles, clean a paint brush and brush our teeth. We use chemicals to reduce labor, improve our health and our quality of life.

Some of the chemicals we use are hazardous. They may be flammable, and could start a fire. Other chemicals may cause cancer or kill wildlife. We must use all chemicals safely and follow the manufacturer's precautions. This includes proper disposal of the chemical when we are finished with it.

The chemicals we use for cleaning and removing grease may react with your skin. Protective goggles, rubber gloves, and a rubber apron must be worn when working with these chemicals. Some chemicals give off a vapor. This vapor can be harmful to our lungs and respiratory system. Wear a respirator and protective goggles when working with these chemicals.

Chemicals, when disposed of improperly, can harm our environment. It is important to collect hazardous chemicals so that they can be disposed of properly. Those in charge of your laboratory or work area will know where hazardous chemicals should be collected. The collection station then calls a disposal firm to take these chemicals away. The disposal firm is licensed to handle chemical waste. They will dispose of them properly.

Name______________________________ Class________________ Date_______

Group Discussion

1. With what chemicals do you come in contact at school, home, and work?

2. Are any of these chemicals harmful to humans or the environment?

3. How do I dispose of motor oil after I change the oil in my car?

4. If I clean a paintbrush or if I use cleaning chemicals, how do I dispose of the residue?

5. How carefully do I measure out chemicals that must be diluted with water for use? What kind of hazard could occur if I were to mix too much chemical into the water?

6. What things could I do right now to reduce the amount of chemical waste in the environment?

Alternative Strategies for Activity Number: Safety.005

Students can study current events of chemical spills in the environment and discuss them in the same manner as the video. Student groups can also respond to the instruction sheet. The instructor can provide information concerning the proper disposal of chemical waste.

Learning/Performance Checks: Safety.005

Group interaction and responses to questions on the instruction sheet will serve as a check for learning.

ACTIVITY NUMBER SAFETY.006

FIRE SAFETY

Description:

Students learn about fire safety and fire categories. Students learn about fire hazards and how to eliminate them.

Rationale:

Fire safety is an important component of a safe living and working environment.

Outcomes:

Students will name and describe types of fire and describe ways of extinguishing them. Students will list some common causes of fire and describe ways of eliminating fire hazards in our environment.

Tools, Materials, Machines, and Resources:

1. Strong, Merle E. (Ed.). (1975). Accident prevention manual for training programs. Chicago: American Technical Publishers. (ISBN 0-8269-4517-1)
2. Supervisor's safety manual. (1973). Chicago: National Safety Council. (ISBN 0-87912-061-4)
3. Fire Safety and Prevention software.
4. Microcomputer.
5. Fire extinguisher found in or near the lab. The software is available from American Association for Vocational Instructional Materials, 120 Driftmier Engineering Center, Athens, GA, 30602.

Instructional Strategy:

Students are divided into groups and complete the lessons in the Fire Safety and Prevention computer program. A guest lecturer from the local fire department demonstrates the safe way to use a fire extinguisher, conducts a walk through inspection of the lab, and emphasizes the correct way to report a fire in the local school area. If possible, students have an opportunity to use a fire extinguisher under the direction of the guest lecturer.

__Safe Practices__:

If using a fire extinguisher, follow the safe procedures outlined for its use.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
_____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Fire Safety

Fire safety affects our living and working environment. Even a small fire can cause loss of life and valuable tools and materials. As you work on the job or in the lab, be aware of the conditions that could cause a fire. Clean up when you finish a job and discard scraps in the proper container. Remove all scraps and trash at the end of the work day.

As you work with the software package in this activity, you will learn about the types of fire and the correct ways of extinguishing them. Study this information carefully. This will help you report a fire correctly. When you report a fire, you must know the phone number of the fire department, and you must know the address and location of the fire. In public buildings, there are fire alarms and fire extinguishers. You should also know the location of both of them.

When a fire alarm is pulled, the alarm goes into the fire department. In the event of fire, always pull the fire alarm before you attempt to fight the fire. This will warn others in the building and allow them to escape safely. When you pull the fire alarm, the alarm will be relayed to the fire department. Be sure someone is watching for the fire department so that the firemen may be guided to the fire location.

To report a fire, call ____________________________

The address of our lab/work area is___________________________

The nearest fire extinguisher is located_________________________

The nearest fire alarm is located____________________________

Alternative Strategies for Activity Number: Safety.006

Students study fire safety from their textbook and take a teacher-made test to confirm learning.

Learning/Performance Checks: Safety.006

The software program monitors student performance on lessons related to fire safety.

Demonstration of appropriate way to use a fire extinguisher suggests correct/desired performance.

ACTIVITY NUMBER SAFETY.007

SAFE PRACTICES IN THE WORKPLACE

Description:

This is an exercise to acquaint learners with the safety rules that must be observed to work in the designated lab. This instruction may be machine-, tool-, or material-specific, depending on the teaching circumstances.

Rationale:

A safe worker will produce more and be more valuable to an employer. Accidents are expensive; they waste material and human resources. An ability to identify an accident-producing situation will help keep you safe in the manufacturing environment.

Outcomes:

Students will be able to list safe practices and rules that should be observed in the laboratory and the workplace.

Tools, Materials, Machines, and Resources:

1. Strong, Merle E. (Ed.). Accident prevention manual for training programs. (1975). Chicago: American Technical Publishers. (ISBN 0-8269-4517-1)
2. Supervisor's safety manual. (1973). Chicago: National Safety Council. (ISBN 0-87912-061-4).
3. Selected tool safety software from American Association for Vocational Instructional Materials.
4. MS-DOS or Apple II family microcomputer.

Instructional Strategy:

Students are divided into groups for study purposes. One or more groups study safety using the personal computers and designated software. The other groups study written materials provided by the instructor or observe a demonstration given by the instructor. When the groups complete their assignments, they change places and complete the other part of the lesson.

Safe Practices:

Observe appropriate precautions with the computer and software. Any demonstrations should be done using all appropriate safe practices. The instructor should provide safe practices as needed for any planned lab activities.

Integrative Skills

Communication:

__x__ Reading
_____ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__xx_ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Safety.007

Working Safely with Tools and Equipment

Working safely is a matter of knowing the rules and developing good work habits. As you work with the safety software, you will learn the rules for working safely with tools and equipment. It is important that you master the rules, but it is even more important that you are able to apply them in the work environment.

In addition to knowing the safe rules and practices, it is important that you learn to identify accident-producing situations. These situations expose you to danger. Some accident-producing situations occur even if you know the safety rules. Be alert when working in any laboratory, shop, or manufacturing facility. Listen to your instructor, boss, and fellow students or workers. Any advice may help you avoid accident-producing situations. When you are uncertain about the safety of any operation, ask for help. Never take chances when working around tools and equipment.

Good work habits mean that you work safely and follow all safety rules. You demonstrate good work habits by avoiding accident-producing situations and by not taking chances with tools or equipment. Your instructor and your boss will appreciate your contributions far more if you work safely at all times.

NOTE: The instructor may wish to provide safety materials related to the machines and tools the learners will be using.

Alternative Strategies for Activity Number: Safety.007

If computer terminals are not available, the instructor can deliver the material in the lecture/demonstration format.

Learning/Performance Checks for Activity Number: Safety.007

The computer programs monitor student responses to each safety lesson. The teacher can monitor student performance at the end of each class. If specialty equipment will be used in the program, the instructor should administer tests that measure mastery of the safety rules for that equipment before using it.

ACTIVITY NUMBER SAFETY.008

SAFETY VIDEO PRODUCTION

Description:

Student groups select a tool or machine and develop a script for a five-minute safety video. The best script is videotaped by the class and used as a training tool.

Rationale:

The application of safety rules to a video is a good way of reviewing and mastering safe work practices. Learners are also exposed to the video as a training tool.

Outcomes:

Students will demonstrate safe practices and a safe attitude through development of a safety script and safety video.

Tools, Materials, Machines, and Resources:

1. Strong, Merle E. (Ed). (1975). Accident prevention manual for training programs. Chicago: American Technical Publishers. (ISBN 0-8269-4517-1)
2. Supervisor's safety manual. (1973). Chicago: National Safety Council. (ISBN 0-87912-061-4)
3. Microcomputer and word processing software.
4. Video recording equipment (usually available from the athletic department or the media center) and appropriate lighting.

Instructional Strategy:

Student groups are assigned or select a tool or machine for the project. The students then write a video script for the selected tool or machine. The script is entered on the personal computer. The group meets with the instructor to discuss and edit the script. The script is then edited and printed. Student groups review the scripts to determine which script should be videotaped. All students contribute to the successful videotaping of the selected script. Note: Two or three rehearsals before actual shooting will improve the final product immensely.

Safe Practices:

Safe practices with videotaping and computer equipment should be reviewed prior to using the equipment.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

______ Assertiveness
__x__ Negotiation
__x__ Listening
______ Risk Taking

Change:

______ Personal Adaption
______ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications________________________________

Decision Making:

______ Ethical Reasoning
______ Logical Reasoning
______ Flexibility

Problem Analysis:

______ Identification
______ Solutions
______ Evaluation
______ Implementation

Safety Rules and Safe Practices

Knowing the safety rules and safe practices related to a portable power tool or stationary machine helps you work safely. One of the best ways of mastering the rules related to any tool or machine is to apply the rules. The best application is with hands-on experience. The second best application is under simulated conditions.

When you write the script for your safety video, you will be applying the safety rules and safe practices in a positive manner. If your script is chosen as a video shoot, you will be able to apply the rules and practices another time. You will also have the opportunity to leave behind a video demonstrating the safe practices and rules for a particular tool or machine.

Study the safety rules and safe practices for the tool or machine you choose before writing the script. Work with your group to decide what rules you can best demonstrate in the video. Try to see the scenes and decide what the audio (sound) portion of the video ought to say. Hint: The audio portion should not say the same thing as you see in the video portion of the scene; it should add some new information.

Once you have agreed upon your script and video, you can use the Safety Video Script Sheet to help you order your thoughts. This rough script may then be used to write a script on a personal computer. This will make it easy to modify your script if you wish to make changes. It will also be easier to print copies for everyone involved with the video production.

When you have selected a script for your video, try a few live rehearsals before you shoot the video. Being well prepared will improve the video and make the video shooting much easier.

SAFETY VIDEO SCRIPT

Title___________________________________ Page______ of _______ Pages

VIDEO SCENE	AUDIO PORTION

Alternative Strategies for Activity Number: Safety.008

If time permits, the instructor can videotape each group's safety presentation. Some of the better ones can be saved for use with other classes. These videos can serve as a model of quality and an appropriate method of learning safety.

If video equipment is not available, then the same scripts could be acted out in a newscast fashion. The application of safety rules exists in this method, but enthusiasm will not be as great.

Learning/Performance Checks: Safety.008

The written script is the first obvious learning check. Individual contribution to the group's script is another method of measuring performance and learning.

The initiative and cooperation shown by each student during the videotaping session are also a performance and learning check.

ACTIVITY NUMBER SAFETY.009

THE ACCIDENT REPORT

Description:

Students study the school accident report form to see what type of information is collected. Student groups stage an accident scenario and fill out an accident report form.

Rationale:

Understanding how accident data are collected will help the learner work more safely and understand some of the fundamental causes of accidents.

Outcomes:

Students will be able to complete an accident report form correctly. Students will be able to read an accident report and identify some of the underlying causes of an accident.

Tools, Materials, Machines, and Resources:

1. Strong, Merle E. (Ed.). (1975). Accident prevention manual for training programs. Chicago: American Technical Publishers. (ISBN 0-8269-4517-1)
2. Supervisor's safety manual. (1973). Chicago: National Safety Council. (ISBN 0-87912-061-4)
3. Accident Investigation: Putting the Pieces Together (videotape available from Lab Safety Supply, P. O. Box 1368, Janesville, WI 53547-1368).
4. Video player.
5. School accident report form or industrial equivalent.

Instructional Strategy:

Learners are aware of the safe operating rules for equipment in their lab. They are divided into small groups and stage a mock accident for another group. The group members who see the accident fill out accident report forms independently and then compare their findings. All groups contribute to a wrap-up discussion. The unit can be introduced with the video Accident Investigation: Putting the Pieces Together. This 18-minute video depicts a simulated accident and shows correct investigative procedures; handbooks are provided. Students may also write out a description of an industrial accident and develop an accident report.

Safe Practices:

All staged accident scenarios should be done with the power disconnected to all equipment.

Integrative Skills

Communication:

_____ Reading
__x__ Writing
__x__ Speaking
_____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

The Accident Report

Accident reports are not only used to record the information relating to an accident, but serve several other purposes. They create an interest in safety among supervisors by furnishing them with information about the accident records of their departments. They determine the principal accident sources so that corrective action can be taken. They provide supervisors and safety committees with information about accident causes, so they can take corrective action. They judge the effectiveness of the safety program by comparing records of similar organizations and past safety statistics.

Accident reports are used to record information on more serious injuries, usually those requiring a doctor's attention or needing three or more treatments. This varies according to company policies and procedures. Accident reports should be completed by the supervisor of the injured person. First aid reports are used by the nurse or first-aid personnel to report every injury, regardless of severity. The accident reports should be accurate and completed as soon as possible after an accident.

The accident report form should include both personal information and information regarding the conditions and circumstances of the accident. The information should include five elements known as the five W's: Who, What, When, Where, and Why. The personal information should include the injured person's name, age, type of injury, and any other information required by the company (who). It should include the date and time of the injury (when). The accident information should include the job that was being performed; tools, machines and materials being used; defective parts, unsafe conditions and any other job-related information (what). It should also include the location of the accident (where), and how the accident occurred, including the things that the injured person may have been doing incorrectly or unsafely (why).

The accident report may also ask for information regarding similar injuries and steps to be taken to prevent future injuries and steps to be taken to prevent future injuries. Copies of this report are then sent to the appropriate personnel as soon as possible. This allows corrective action to be taken as soon as possible.

Name________________________ Class__________________ Date_______

Questions for Discussion

1. Did everyone in your group fill out the accident report form in the same way? How did the reports differ?

2. Why do you suppose the accident report forms were filled out differently by some students?

3. Did the accidents staged in your class have any common elements? If so, what were they?

4. What were some of the unsafe acts that caused the accident?

5. Did any unsafe conditions contribute to the accident?

6. What things could be changed to eliminate the cause(s) of the accident?

7. Would you categorize the changes as education, engineering, or enforcement?

Alternative Strategies for Activity Number: Safety.009

The instructor can provide some examples of accident report forms that lead the learner to certain hazards or laboratory problem. Students can decide on the causes and cures for the accidents presented in the forms.

Learning/Performance Checks: Safety.009

If the video is used, the activities furnished with the video can be used to evaluate performance.

Participation in the mock accident and the class discussion can also check for learning.

ACTIVITY NUMBER SAFETY.010

ERGONOMICS & SAFETY

Description:

This activity will acquaint the learner with the term "ergonomics" and help the learner understand how ergonomics affects product design and safety.

Rationale:

An understanding of ergonomics will help the learner select products for safety and comfort. Products that are ergonomically sound are safer and stress the body less with repeated use.

Outcomes:

Students will be able to define ergonomics and list the three components of ergonomics. Students will be able to evaluate various products for comfort, safety, and design.

Tools, Materials, Machines, and Resources:

1. Eggleton, Elizabeth. (1983). Ergonomic design for people at work. New York: Van Nostrand Reinhold. (ISBN 0 534 97962 9)
2. Singleton, W. T. (1972). Introduction to ergonomics. Geneva: World Health Organization. (ISBN 92 4 1560 38X)
3. Some examples of ergonomic design such as a dashboard, several tools used to do the same job, but designed differently; or a series of chairs (children's, adult library, and adult dining); or a series of computer terminals of various design.

Instructional Strategy:

Students read the information sheet and proceed to evaluate the chairs, computer terminals, tools, or dashboard. If there are enough items to study, the students can be divided into groups. Each group can study a particular product and report back to the class. If the dashboard is used, each student can adjust the seat, seat belt, mirrors, and wheel tilt to suit his/her body. If the computer terminal is used, each student can adjust the monitor for angle and brightness, and the chair for comfortable height.

Safe Practices:

If power tools are used as part of the study, be sure that they are disconnected from the power source.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
__x__ Evaluation
_____ Implementation

Ergonomics is the technology of work design. It is the study of human anatomy, physiology, and psychology. Human anatomy focuses on body dimensions and body power--the strength and endurance of any human. Human anatomy helps designers make the machine or tool fit the human body as well as possible. Designers also make sure that all humans are strong enough to use the machine or tool. This may require mechanical assistance such as power steering on an automobile.

Human physiology looks at the amount of energy required to do a job with the tool or machine. It also considers the environment and its effect on the worker. For example, the work may be easy if the temperature is 70 degrees F., but the work may be exhausting if the temperature is 90 degrees F. or higher. Designers then look at possible changes in the tool or machine or the physical environment. Any changes should reduce the stress on the worker and make it easier to do the job. An example would be a tool that makes your hand sore after an hour of use. An ergonomic change would be a handle that made your hand comfortable for eight hours or more.

The psychology component of ergonomics considers skill psychology and occupational psychology. Skill psychology is human reaction to machine or tool feedback. This might be your reaction to the speedometer or the brake lights of the car in front of you. Skill psychology studies your reactions and seeks to improve the speed or accuracy of your reaction. Occupational psychology is the training required to obtain the best performance when working with a tool or machine. This considers how much effort each person would have to expend to master the training. A study of occupational psychology helps designers make tools or machines easier to understand and operate. It can also help industrial trainers determine what has to be included in manuals and training.

Alternative Strategies for Activity Number: Safety.010

Students can study a list of standard sizes for furniture and discuss how this list was developed. This list is found in many woodworking books. A schematic of a properly designed computer terminal may also be used as a substitute.

Learning/Performance Checks for Activity Number: Safety.010

A verbal check for definition of ergonomics should be used in the discussion. Individual comments made when products are studied will suggest learning and understanding. The worksheet below can be used for a learning check.

Ergonomics can be defined as:

____

____

The three components of ergonomics are:

1.________________________

2.________________________

3.________________________

Discuss some ways in which ergonomics can be applied to:

Automobiles____

Tools____

Furniture____

Computer terminals____

ACTIVITY NUMBER SAFETY.011

ERGONOMIC DESIGN

Description:

This activity will help the learner apply ergonomic factors to real-life situations through the analysis of a tool, product, or machine.

Rationale:

Comparison and evaluation of tools and equipment for ergonomic factors help the learner select the safest and best tool for any task.

Outcomes:

Students will be able to evaluate tools, products, or machines, and identify ergonomic factors that affect job safety.

Tools, Materials, Machines, and Resources:

1. Eggleton, Elizabeth. (1983). Ergonomic design for people at work. New York: Van Nostrand Reinhold. (ISBN 0-534-97962-9)
2. Singleton, W. T. (1972). Introduction to ergonomics. Geneva: World Health Organization. (ISBN 92-4-1560-38X)
3. All tools, products, or machines used in this activity are furnished by the learner.

Instructional Strategy:

After completing ergonomics in unit one (Safety.010), students select a tool or product from their world and analyze it for ergonomic design qualities. Their analysis is presented to a student group or the class. Student findings are compared and generalizations are developed concerning ergonomics.

Safe Practices:

Any tools, machines, or products should be disconnected from their power source during the analysis.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

______ Assertiveness
______ Negotiation
______ Listening
______ Risk Taking

Change:

______ Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications______________________________

Decision Making:

______ Ethical Reasoning
______ Logical Reasoning
______ Flexibility

Problem Analysis:

______ Identification
______ Solutions
___x___ Evaluation
______ Implementation

Ergonomics

Ergonomics is the technology of work design. When a product is analyzed for ergonomic design, there are several factors considered. Body size and body strength are considered first. How large or how small can a person possibly be and still operate the product successfully? The strength required to use the product is also a design consideration. The goal of good ergonomic design is to reduce the strength required to operate the device.

In addition to strength, the duration of use is also considered. Can the average person use the tool for eight or more hours per day without fatigue or stress? If not, how can the design be modified or improved? The design should use the least amount of strength and energy.

Ease of use is another consideration of ergonomic design. How much training does an individual need to operate the object successfully and safely? Operation of some products such as a jet airplane will be more difficult to learn than other objects such as a can opener. In either case, the product should be designed for ease of operation and understanding. If you cannot understand the gauges in the cockpit of an airplane, then you cannot use the information successfully. The design should be improved to make the gauges easier to understand and the airplane safer to fly.

After learning about ergonomics and studying some products for ergonomic qualities, it is time to apply what you have learned. Select a product, tool, or machine for ergonomic analysis. Be sure to get your instructor's approval before you start. Do a careful job of analyzing the object. You will later report your findings to your classmates.

Name________________________________ Class_______________

Product Selected_______________________________ Inst. Approval______

Product Analysis

1. How does body size or body strength affect the use of the product?
2. Are there people who would have trouble using the product?
3. Has the product been designed to reduce the fatigue of the operator? How?
4. How does the physical environment affect the use of the product?
5. How does a human being interact with or react to the feedback of the product selected?
6. What type of training does one need to use the product?
7. Can you think of any errors one could make without training or an operator's manual?

Alternative Strategies for Activity Number: Safety.011

The instructor can examine some tools, machines, or products for ergonomic design in front of the class. Class discussion and questioning can be used to do the analysis. The instruction sheet can be used to help guide the analysis. The instructor can also assign a group to a product for ergonomic analysis and a class report.

Learning/Performance Checks: Safety.011

Learning is observed through the individual presentations and class contributions. Responses to questions on the instruction sheet can also be used as an indicator of learning.

ACTIVITY NUMBER SAFETY.012

PRODUCT LIABILITY

Description:

Students learn about the responsibility of a manufacturer to produce goods that are safe and will not injure the user. Students analyze some products for safe design and use as part of their lab activity.

Rationale:

Individuals who will be working in the manufacturing field should know why it is important to manufacture safe and hazard-free goods.

Outcomes:

Students will be able to define the term "product liability" and identify ways in which manufacturers develop safe and hazard-free products.

Tools, Materials, Machines, and Resources:

1. Freedman, Warren. Product liability. (1984). New York: Van Nostrand Reinhold. (ISBN 0-442-22493-1)
2. Noel, Dix, & Jerry J. Phillips. Product liability. (1981). St. Paul: West Publishing Company. (ISBN 0-8299-2121-4)

Instructional Strategy:

Students read the information sheet and discuss the questions at the end of the sheet. Students then divide into groups and observe several owner's manuals for manufactured products. Students comment on the way in which the manual warns the user of any potential hazards. Students may also research a product liability case from the library and report their findings in class.

Safe Practices:

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

What Is Product Liability?

Product liability is determined by a series of laws designed to protect consumers. These laws are concerned with any injuries that may be caused by a product. The injuries may be caused during manufacturing, processing, or distribution. Product liability laws protect consumers from dangerous or hazardous products that could injure them.

It is also possible that an injury may occur with a perfectly well designed product. For example, if you cut yourself with a hunting knife, it is not likely that there is any product liability since the knife was designed to cut. If the manufacturer of the knife advertised the product as a knife that would cut anything, there might be product liability since the knife would not normally cut tool steel or stone materials. In this case, the manufacturer misrepresented the product.

Misrepresentation means the manufacturer said the product would do something that it would not do. It could also mean that the manufacturer said the product was safe for a certain operation, but was not actually safe for that operation. For example, if the manufacturer said that it was safe to use a tool in water and its use electrocuted the operator, the tool may have been misrepresented.

A manufacturer must warn the user of any danger posed by the use of the product before and after purchase. If a product is found to be hazardous two or three years after manufacture, the manufacturer must warn every owner of the hazard. Failure to warn all consumers suggests the manufacturer is not working ethically. In this case, anyone who is injured can seek punitive damages. Punitive damages are an extra penalty awarded to the injured consumer who was not warned of a hazard that the manufacturer knew of.

Most manufacturers consult with safety experts, lawyers, and designers when they bring a new product to market. The advice of others helps the manufacturer to be sure that the product is absolutely safe. In many cases, the manufacturer buys insurance as protection from a product liability lawsuit. The insurance may protect the manufacturer from financial disaster caused by a lawsuit. Some manufacturers cannot afford this insurance because the premiums are too expensive. They are said to be self-insured and could be ruined by a product liability suit.

The owner's manual is also an important defense against a product liability suit. The owner's manual warns the consumer of any hazards and gives information about the correct use of the product. A well-written manual can reduce the chance of a product liability suit.

Power tools are an example of a product group that is frequently involved in product liability cases. The older a power tool, the more likely it will be in a product liability suit. This is because newer products are safer, and older products tend to wear out and become dangerous. As a power tool gets older, it is sold many times and it is modified, yet the original manufacturer is still responsible for it. It is impossible for the manufacturer to warn all the owners of the tool 10 or 20 years after it was sold the first time.

Name______________________________ Class____________ Date_____

Questions for Discussion

1. How would you define "product liability"? Do you know of any product liability cases?

2. A valve is manufactured and delivered to an industry that uses the valve in its product. The product is then sold to a consumer by a distributor. If the valve is defective and the consumer is injured, who will the consumer file a lawsuit against? Who is liable for the defective valve?

3. How would you define "misrepresentation" of a product?

4. How does the manufacturer warn the consumer of a hazard before the product is sold? How does the manufacturer warn someone after the sale has been made?

5. What are "punitive damages"? Why would they be awarded to a consumer?

6. When a manufacturer buys insurance against product liability, who pays the insurance premiums? Do these insurance premiums affect the list price of the product?

7. Why is the owner's manual so important in product liability cases?

8. Why do you think so many power tools are involved in product liability cases?

9. Do you think a manufacturer should be liable for a power tool forever? Why?

10. How long do you think an automobile manufacturer should be liable for an automobile it produces? Should the time be the same for manufacturers from other countries? Why?

11. Do you think that the manufacturer should be held liable for the product no matter how many people have owned it? Why?

Alternative Strategies for Activity Number: Safety.012

Students research a product liability case from the Reader's Guide and write an abstract on the case. The students then do an oral report of their findings.

Learning/Performance Checks for Activity Number: Safety.012

Student's responses to discussion questions will be an indication of learning.

Group participation in the critique of owner's manuals will also be a check for learning.

ACTIVITY NUMBER SAFETY.013

PRODUCT LIABILITY--CASE STUDIES

Description:

Through a series of case studies, student groups explore decisions that must be made related to product liability, job retention, consumer needs, and the reputation of the manufacturer.

Rationale:

Students who work in a manufacturing facility should be aware of decisions that must be made to protect the consumer from injury and the manufacturer from liability.

Outcomes:

Students will be able to identify factors that affect decisions made about product liability and discuss the legal and moral aspects of these decisions.

Tools, Materials, Machines, and Resources:

1. Freedman, Warren. Product liability. (1984). New York: Van Nostrand Reinhold. (ISBN 0-442-22493-1)
2. Noel, Dix, & Jerry J. Phillips. Product liability. (1981). St. Paul: West Publishing Company. (ISBN 0-8299-2121-4)
3. Case studies and discussion sheets which are included in this activity. Students should complete Safety.012 before starting this activity.

Instructional Strategy:

Students are divided into groups to study the assigned case study. The students respond to the discussion questions to learn how they feel about the decisions made in the case study. The instructor then solicits opinions from each group concerning its case study.

Safe Practices:

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

In order to make a safe and reliable product, manufacturers must be sure that all parts are safe and assembled correctly. This requires quality checks at various manufacturing steps. In some organizations, quality control is the responsibility of every worker. In other organizations, there is a quality control department that checks product quality as the products are manufactured. In either organization, responsible workers check products for quality and safety.

A product that is manufactured poorly could invite a product liability suit. If the product injures someone or causes property damage, legal action may be taken against the manufacturer by the consumer. This action could generate financial problems for the business and it could put some employees out of work. One thing is certain: A product liability case will damage the reputation of the manufacturer and the products it produces.

Case Study Number One--The Instruction Manual

The Jones Manufacturing Company has been working diligently to beat its competition in the power tool market. There has been a trend among buyers to accept a new type of portable power saw that works differently than any other one on the market. The Jones company has completed its prototype and believes that it can be the first company to introduce this new saw. They know that if they are the first saw on the market, they are likely to sell better than any other competitor. Mr. Tumey, the manufacturing manager introduces the prototype to all of the executives at a meeting. After a demonstration, everyone is excited and wants to begin production immediately.

Mr. Tumey says that production can begin early next week, but no packaging is available, and there is no owner's manual ready for the saw. Dave Jones, the president, suggests that standard cardboard packaging is available and that the secretarial pool could type up an owner's manual. This manual could be photocopied and put in every container for the present time.

Ed Lewis, the director of safety, wants a well-produced safety manual for the new saw. The owner's manual should show the owner how to use the tool safely, and it should have line drawings or photographs of the correct way to use the tool. Mr. Tumey responds that the cost of such a manual will raise the unit cost of each tool about two dollars. It will also take three weeks to get such a manual together--we cannot afford the time.

Bob Johnson, the director of sales, feels that a manual will help the sale of the product, but he is worried that some other company might get the jump on sales if the tool is not brought to market soon. Mr. Johnson also wants a color carton for the tool. He feels that it will increase sales. Ed Lewis agrees that the box should be in color, and that the illustrations should show the tool being used safely.

Questions for Discussion

1. What do you see as the major issue in this case?
2. What two elements are making it difficult to bring the saw to market?
3. How important is the manual to the overall success of the saw?
4. Will the saw sell with a typewritten manual?
5. What could happen if a consumer was injured by the saw simply because the manual did not warn of the hazard?
6. What kind of image or reputation does the manufacturer get when a product is dangerous or just perceived as dangerous?
7. Could the color package be used as a safety and sales tool? How do you see the color package looking?
8. If you were Mr. Jones, what would you do? What decisions would you make concerning the package, and the owner's manual?

Case Study Two--The Faulty Valve

Ray Nelson was just hired at the Wysong Manufacturing Assembly Plant. His first job was that of an assembler on the second shift. Before going to second shift, he was given training on the first shift with the assembly trainer Bud Thompson. Bud was an expert at training and every assembly job at Wysong. He was easy to get along with and he made the job seem easy.

During the training, Bud showed Ray how to test the valves that went on the propane burners. He said: "You must test every single valve as you assemble the units! If you don't, there could be an explosion when the unit is started. This could injure or kill anyone standing near the unit. We have never had an explosion and that's because we test every valve before it leaves here." Ray was impressed with this lesson and felt personally responsible for the safety of each unit that he assembled.

The next Monday, Ray began work on the second shift as an assembler. Ray enjoyed the job and worked carefully and accurately. His supervisor, Mr. Laseman, was impressed with the quality of his work, but he wished that Ray would work a little faster. Two weeks later, Mr. Laseman teamed Ray up with Ed Cooke. Ed was the fastest assembler in the whole plant. Mr. Laseman hoped that working with Ed would show Ray how to pick up speed.

Ed Cooke observed Ray at the job and later asked: "Why are you testing those valves? They are fine." Ray responded, "Bud Thompson trained me to check every single one of them." Ed laughed, and said: "Bud Thompson doesn't know what he is talking about. I've never checked a single valve in the past three years, and there's never been a problem. You would be better off to worry about keeping your job than checking valves." Ray asked what he meant. Ed replied: "If you don't get your assembly speed up soon, Laseman will fire you!" As Ed left the plant that night, he wondered what he would do.

Questions for Discussion

1. If you were Ray, how would you feel?
2. Ed Cooke has not checked a valve in three years and he says that there has "never been a problem." How would he know if there was a problem?
3. If a valve failed and someone was injured, what do you think would happen? Who would be found liable?
4. If a product liability suit broke the company, where would the employees find work?
5. Do you think that it is the responsibility of all employees to produce a quality, hazard-free product?
6. Do you think Bud Thompson knows what he is talking about? Why is his message different than Ed Cooke's?
7. Why is Mr. Laseman so concerned with production? How do you think he feels about quality and safety?
8. If employees are rushed to produce, do you think that they can work safely and produce safe products?

Alternative Strategies for Activity Number: Safety.013

Students research a product liability case for some of the manufacturer's decisions that accounted for the liability case.

Learning/Performance Checks: Safety.013

Completion of the case studies and questions at the end of the Activity will serve as a learning check.

ACTIVITY NUMBER SAFETY.014

PERSONAL PROTECTIVE EQUIPMENT

Description:

Students learn about personal protective equipment used in their lab and its importance in the living and working environment.

Rationale:

Personal protective equipment is elementary to working safely and coping with workplace hazards. A positive attitude toward personal protective equipment is essential to safe working habits.

Outcomes:

Students will demonstrate a positive attitude toward personal protective equipment and its use. Students will be able to identify situations where certain types of personal protective equipment should be used.

Tools, Materials, Machines, and Resources:

1. Strong, Merle E. (Ed.). (1975). Accident prevention manual for training programs. Chicago: American Technical Publishers. (ISBN 0-8269-4517-1)
2. Supervisor's safety manual. (1973). Chicago: National Safety Council. (ISBN 0-87912-061-4)
3. Bet Your Eyes and Working Safely (videos available from Illinois Power).
4. Video player and monitor.
5. Personal protective equipment found in the laboratory including: protective glasses, face shields, goggles, hearing protectors, rubber gloves, dust masks, and respirators.

Instructional Strategy:

The instructor provides a lecture on the types of personal protective equipment used in the lab and demonstrates the correct use of each. Students are polled to see how they feel about the use of personal protective equipment. The instructor points to several role models in sports who use personal protective equipment every day.

To further convince the students of the importance of personal protective equipment, students will be divided into groups and asked to wear a patch over one eye to see what it would be like to have a vision problem. Students will then put on protective glasses with Vaseline smeared on the lenses to simulate vision damaged by an injury. Students try common activities such as tying a shoe, threading a needle, reading the paper. Groups are then polled to see if there has been a change in attitude concerning personal protective equipment. The instructor tries to get a commitment to the use of personal protective equipment from every student at this time.

Safe Practices:

Students can monitor each other during the activities to keep them from incurring an injury.

Integrative Skills

Communication:

_____ Reading
_____ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
__x__ Listening
_____ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
__x__ Evaluation
__x__ Implementation

Personal Protective Equipment

Just as a football player wears a helmet and shoulder pads, people working in a shop wear protective glasses and other necessary protective equipment. Personal protective equipment will protect you from hazards in any working environment. Steel-toed shoes will protect your feet from falling objects or the tires of a fork lift or truck.

Dust masks and respirators protect your lungs and respiratory system from damage. Many dusts can harm your lungs and respiratory system. These dusts can be the cause of cancer and other industrial diseases. These diseases do not show any symptoms for a long time, so it is important that you protect yourself from dusts and chemicals in the air.

Protective glasses, face shields, and goggles protect your eyes and face from sparks, chips, or other objects. Your vision is important to everything you do. Imagine working without your sight; even the simplest task would be almost impossible without your sight.

Another important element of personal protective equipment is hearing protection. Hearing protection is important in a noisy environment. The louder the environment you work in and the longer you are exposed to noise, the more likely you are to lose some of your hearing. Hearing protectors also reduce fatigue to the operator. Noise generates stress and fatigue on the operator. Noise generates stress and fatigue. Wearing hearing protection will make work in a noisy environment more comfortable.

Alternative Strategies for Activity Number: Safety.014

The instructor can integrate the use of personal protective equipment into lectures and demonstrations where personal protective equipment is needed.

Learning/Performance Checks: Safety.014

Use of appropriate personal protective equipment in the laboratory is the check for performance.

BUSINESS ECONOMICS

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UNIT GOALS

1. Define the terms "profit" and "loss" and discuss why profit is important to success in manufacturing. (Busecon.001)
2. Describe how profits are divided among workers, executives, and shareholders. Discuss the percentages of profit that are used as compensation and reinvestment. (Busecon.002)
3. Name and describe the elements that must be considered when determining unit cost and list price of a product. (Busecon.005)
4. Define "overhead" and list at least 10 factors that can be included in product overhead. (Busecon.001, .003, .006)
5. List at least 10 types of employee benefits commonly furnished in most industries. (Busecon.002, .007)
6. Describe the impact employee benefits have on overhead and the development of a talented work force. (Busecon.004)
7. Analyze an industrial concern for assets, liabilities, overhead, relative value, and potential for growth. (Busecon.005, .006)
8. Define the term "value added" and trace a raw material through the steps required to become a part or finished product. (Busecon.005, .006)
9. Define the term "human resources" and discuss the impact human resources have on profit and overhead. (Busecon.007)
10. Analyze a consumer problem caused by a manufactured product and trace the steps required to gain customer satisfaction. (Busecon.008)
11. Discuss the impact of customer satisfaction on overhead and reputation. (Busecon.008)
12. Trace the history of consumer rights in the United States. Cite events that have changed how consumers regard and buy products. (Busecon.008)
13. Define the term "truth in advertising" and name the agency that governs truth in advertising. (Busecon.008)

ACTIVITY NUMBER BUSECON.001

BUSINESS SIMULATION--PROFIT AND LOSS

Description:

Student teams operate a computer-simulated business to learn the basics of business as they apply to manufacturing. Students then discuss their experiences as a class. Use of information sheet provided with the software is helpful.

Rationale:

Students become more valued employees when they understand how a manufacturer earns a profit and makes business decisions.

Outcomes:

Students will define the following terms: profit and loss, wages, cost of goods sold, advertising, cash flow, and loans, and then discuss their application and significance in a manufacturing situation.

Tools, Materials, Machines, and Resources:

1. Fales, James, et al. Manufacturing: A basic text for industrial arts. Bloomington, IL: McKnight Publishing Co., 1980.
2. Rudelius, William. An introduction to contemporary business. New York: Harcourt, Brace, Jovanovich, Inc., 1973. (ISBN 0-15-541641-3)
3. Teddytronic. ALBIS Pub. order ALG5401A.
4. Apple IIs, 48K computer.

Instructional Strategy:

Students are divided into teams of two to four players. Each team goes through the process of taking over a teddy bear manufacturing plant to learn manufacturing economics and management principles. After all teams have completed the simulation, the instructor wraps up with a discussion of key concepts such as: profit and loss, wages, cost of goods sold, advertising, cash flow, and loans. The instructor makes sure that all students know how they can contribute to profit or loss in a manufacturing facility.

Safe Practices:

Work carefully with software and microcomputer so that software is not damaged or erased.

Integrative Skills

Communication:

__x__ Reading
_____ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications__Manufacturing______________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

As products are sold, money is returned to the manufacturer. The money is not all profit; in fact, only a small portion is profit. Before a profit can be realized, several costs must be deducted from the money returned to the manufacturer. The first deduction is the cost of goods sold. The cost of goods sold is the cost of the raw materials used to make the product.

The next cost is that of wages and benefits for all employees. This cost must be paid to keep employees working and producing goods. The benefits may include health and life insurance, pension funds, child care, dental care, family picnics, etc.

When the retail sellers of a product do not pay for their goods in a prompt manner, there is no cash flow. Cash flow is the stream of payments that go to the manufacturer and pay for the products retail sellers have ordered. Without cash flow, no bills can be paid. A loan may be needed to cover the cost of doing business. Even the interest on the loan becomes a cost of doing business.

Advertising is another cost that is paid out of profit. Advertising helps sell products. Advertising tells the consumer what the product will do and how it will benefit them. There are other costs of doing business. As you work with the software simulation, you will learn of other costs that affect the profit of any manufacturing facility. You will be able to discuss these costs with your classmates after you complete the simulation.

Alternative Strategies for Activity Number: Busecon.001

If software is not available, the instructor can give a lecture on the concepts listed above using the instruction sheet on the preceding page.

Learning/Performance Checks: Busecon.001

Completion of the manufacturing simulation and participation in the discussion afterward will be a measure of learning.

ACTIVITY NUMBER BUSECON.002

BUSINESS SIMULATION--WAGES, HIRING AND FIRING

Description:

Students work independently or in groups to learn about wage theory. This is done through computer simulation.

Rationale:

An understanding of how an employer develops a wage schedule is important to becoming an effective employee. Attitudes toward wages will be formed in a positive manner.

Outcomes:

Students will be able to describe how wage levels are established. They will study ways in which employers hire, promote and fire employees based on their ability to produce and according to their age level. Students will be able to define how benefits affect overall wages.

Tools, Materials, Machines, and Resources:

1. Fales, James, et al. (1980). Manufacturing: A basic text for industrial arts. Bloomington, IL: McKnight Publishing Company.
2. Rudelius, W., et al. (1973). An Introduction to contemporary business. New York: Harcourt, Brace Jovanovich, Inc. (ISBN 0-15-54163-3)
3. Wage Theory software.
4. Apple IIs, 48K computer.

Instructional Strategy:

Students are divided into groups of 4 to 6, or they may work independently. After they complete simulation, students work in groups to study the jobs offered on the instruction sheet and respond to the related questions. The instructor wraps up by emphasizing the concepts concerning wage levels and the factors that determine wage level.

Safe Practices:

Work carefully with the software so that it is not damaged or erased.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
_____ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

When you look at a number of jobs advertised in the newspaper, the pay rates vary considerably from job to job, even if the job description is the same. While this may seem odd, it may be that the jobs are not the same. Some jobs offer paid holidays and/or health insurance. To do this, they reduce the hourly rate or the salary is reduced. The benefits may be far more valuable than the increased wage. Just one claim against the health insurance could be larger than one year's wages.

As you work with the software simulation on wages and salaries, you will learn how wages and salaries are determined. The information you gain here will help you select a job. You will look at more than the hourly rate. This will help you make an informed decision.

Job Hunting Activity

You are looking for an entry-level job in the manufacturing sector. After conducting a search of the various employment agencies and help-wanted pages, you have lined up four interviews. You have been offered all four jobs, and you must decide which job is best for you.

Job Number One

This job is not quite full time. You work five six-hour shifts with Saturday and Sunday off. The job pays $8.00 per hour and there are no benefits or paid holidays.

Job Number Two

This job is 40 to 50 hours per week. It pays $7.00 dollars per hour and your days off are Saturday and Sunday. Your new boss says that he'll pay you in cash so that you do not have to pay any taxes or Social Security. There are no benefits or paid holidays.

Job Number Three

This job is 40 hours per week. It pays $5.50 per hour and your days off are Sunday and Monday. This job offers health insurance, but you have to contribute $5.00 per week to the fund. There are seven paid holidays per year and you get a one-week paid vacation next year.

Job Number Four

This job is 40 hours per week. It pays $5.00 per hour, and your days off are Monday and Tuesday. This job offers health insurance with no deductible. There are seven paid holidays per year and you get a one-week paid vacation next year. In addition, you qualify for advancement in six months, and/or you can go to the second shift for a 10% bonus after one month of training.

Questions for Discussion

1. Which of the jobs listed above appeals to you? Why?

2. If you cheat the government out of some income taxes and Social Security, what do you think will happen if you get caught?

3. If you only work 30 hours per week, are you considered a full-time employee? Would you qualify for unemployment compensation if you were laid off?

4. How do you feel about a job that requires you to work Saturday and Sunday? How would this affect your social and religious activities? Can you think of some benefits related to having Monday and Tuesday off?

5. Do you think it would be worth a 10% pay increase to work the second shift? What things would you have to change in your lifestyle to work on the second shift?

6. How valuable is the training that you will get with Job Number Four? Do you think the training might make you more valuable or more employable?

7. If you were injured on Job Number Two, do you think that you would qualify for Worker's Compensation? Do you think that your boss is contributing any money to this insurance fund?

8. How valuable is a paid holiday? Do paid holidays help you budget your money?

9. What could you do with a paid vacation if the job barely paid enough to live on?

10. Suppose you had to have emergency surgery a couple months after you started working; which job would be best?

Alternative Strategies for Activity Number: Busecon.002

The instructor could use the instruction sheet only and eliminate the computer exercise.

Learning/Performance Checks: Busecon.002

Proficiency on computer software will be a learning check. Additional learning will be demonstrated by responses to the questions for discussion and oral responses in class.

ACTIVITY NUMBER BUSECON.003

BUSINESS SIMULATION: UNDERSTANDING OVERHEAD

Description:

Students start a computer-simulated business to learn about trade name, partnerships and incorporation, budgeting, marketing, inventory, insurance and other forms of overhead.

Rationale:

Students become more valued employees when they understand that control of overhead can enhance profits and reduce operating costs.

Outcomes:

Students will be able to define overhead in business and list some ways that overhead can be reduced. Students will be able to differentiate between income and profit.

Tools, Materials, Machines, and Resources:

1. Abramowitz, I. (1967). Production management. New York: The Ronald Press.
2. Rudelius, W., et al. (1973). An Introduction to contemporary business. New York: Harcourt, Brace Jovanovich, Inc. (ISBN 0-15-541641-3)
3. Apple IIs, 48K; or IBM 64K, 2 disks; MacIntosh 128K, or Amiga 256K microcomputer.
4. Intellectual Software Pub. Numbers INT 9054A, INT 9059B, INT 9054M, INT 9054E, software (Starting a New Business).

Instructional Strategy:

Students work independently or in groups to start a new business using the software listed above. After they complete the simulation, students discuss their findings with their classmates to reinforce the concepts of overhead.

Safe Practices:

Work carefully so that software is not damaged or erased.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
__x__ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Overhead is the cost of doing business. If overhead is reduced, then the cost of the product can be decreased or the amount of profit can be increased. Most industries are concerned about increasing overhead. If someone is hired, that person becomes part of the overhead. That is why it is important that everyone contribute more to the profit than he/she does to overhead of the business.

In most cases, when a manufacturing business grows, the overhead increases. Overhead does not increase as fast when the manufacturing business grows. This is because there is more efficiency in each job. When the amount of business decreases, the amount of overhead per person increases. The manufacturer may lay off help if business decreases. This helps reduce overhead and keep the business profitable. When the business is no longer profitable, the manufacturer looks for new products or considers going out of business.

Employees are only one portion of the manufacturer's overhead. There are many other areas of overhead such as: accidents, lawsuits, utilities, office supplies, manufacturing tools and equipment purchases, maintenance and repair, insurance, uncollectible debts, product design and research, marketing, inventory, advertising, and taxes.

Some overhead is necessary to do business. For example, it is difficult to sell merchandise without advertising. The question seems to be how much advertising is too much advertising. There are some businesses asking this question every day. They know that advertising is important, but they do not want to spend beyond efficiency. Advertising should pay for itself as a part of overhead either through sales or reputation.

Questions for Discussion

1. As an employee, do you see yourself as overhead or as an asset to the business? Why?

2. What ways can a good employee help reduce overhead in a manufacturing facility?

3. How does waste (waste of time, or materials) affect overhead? Can employees reduce waste with good work habits? List some examples.

4. How does an accident affect overhead in a manufacturing facility? What other areas of overhead are affected by an accident?

5. Utilities are a major part of overhead in some industries. What are some of the utilities that an industry must use to keep manufacturing on schedule?

6. How important is research and development to an industry? Would this overhead area be the first one to be eliminated during difficult times? Why?

7. How does too much inventory (merchandise on hand) affect overhead? What are some ways of reducing this inventory?

8. Some types of equipment will increase production dramatically, but their initial cost is very high. What would influence the purchase of equipment that increases productivity? How is this increase in overhead justified?

9. In an effort to reduce overhead, your employer has decided to lay you off with little chance of recall. How would you feel? What would you do?

Alternative Strategies for Activity Number: Busecon.003

The instructor can discuss the concept of overhead and its elements in a lecture format. The information sheet and discussion questions can also be used during this session.

Learning/Performance Checks: Busescon.003

Participation in discussion activities and responses to discussion sheet will check for learning. Actual involvement with the computer simulation will also check for learning.

Safe Practices:

Work carefully so that the software is not damaged or erased.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

__x__ Personal Adaption
__x__ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Busecon.004

Technology and Your Job

The rapid advancement of technology has changed the way in which we work. Many jobs use automated controllers, robotics, and other technological innovations. These changes in technology mean that our jobs also change. We will no longer do the same job all of our adult life. New jobs will require additional training. This training will enable you to remain competitive in the world of work.

Another advantage of additional training is that you will be able to perform a number of different jobs. This makes you a more valuable employee. If another employee is ill, you can perform that job. This keeps things running smoothly and does not slow production.

Change is occurring all around us. We may view change as being good or bad, but this is simply how we see it. The way we travel has changed over the past three decades. Trains were the most common method of travel, but in the past three decades trains have lost ground to cars, busses, and airplanes. During the last decade, jet planes have taken over most travel arrangements. Some of these changes may seem good, and others may seem bad. You may be able to list some good points and some bad points about our changes in travel. The change has occurred however and there is little we can do; we must accept it or change it.

As you work with the business simulation software, you will be able to apply change to the workplace. The changes you make will be seen by others as good or bad. Try to think about the changes you make and how they will affect others.

Questions for Discussion

After working with the software in this activity, please answer the following questions.

1. Is the use of technology always the appropriate way to improve manufacturing?

2. Did you notice that shifting people from one job to another actually increased production?

3. As a new employee in any manufacturing job, do you think that it is important to know how to do more than one job?

4. As a job changes because of new technology you will have to learn new skills and adapt to change. How important is your attitude to change?

5. The world is constantly changing around us. Can you name some ways that we adapt to change? Do you think that change will increase or decrease its pace in the next decade?

6. Can you name some products that did not exist when you were born? Tell how these products have changed the way we live and work.

Alternative Strategies for Activity Number: Busecon.004

The instructor can substitute a lecture and discussion on how change and adaptability are important job skills in today's market.

Learning/Performance Checks: Busecon.004

Computer activities and responses to discussion questions will serve as learning checks.

ACTIVITY NUMBER BUSECON.005

THE COST OF A PRODUCT

Description:

Students learn about the cost of a product to the consumer, wholesaler, and manufacturer. Students learn about the cost of doing business and how it affects the price of any product.

Rationale:

Students must realize that there are many elements that contribute to the overall cost of a product. This knowledge will make them aware of costs in the work world.

Outcomes:

Students will be able to list various costs that affect the price of a product. Students will discuss concepts such as how overhead and customer satisfaction affect the price of a product.

Tools, Materials, Machines, and Resources:

1. Fales, James, Everett Sheets, Gregg Mervich, & John Dinan. (1980). Manufacturing: A basic text for industrial arts. Bloomington, IL: McKnight Publishing Co.
2. Rudelius, William, W. Bruce Erickson, & William J. Bakula, Jr. (1973). An introduction to contemporary business tools. New York: Harcourt Brace Jovanovich, Inc. (ISBN 0-15-541641-3)

Instructional Strategy:

A person from the retail or manufacturing sector is invited to speak to the class about the cost of products and where the money goes when a product is sold. Students will use the information sheet and discussion questions to learn more from the guest speaker. The information sheet and discussion questions should also be furnished to the guest speaker.

Safe Practices:

None.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

When you buy any manufactured product, you have considered the price and decided that it is worth what you must pay. Have you ever considered what makes up the cost of the products you buy? The price includes a profit and money to replace the raw materials used to make the product. The price also includes other elements such as: research and development, customer service, insurance, advertising, and other overhead.

The research and development department invests a great deal of time and money in the design of new products. Some of these products never make it to market; others become a success immediately; and still others sell steadily for years. The cost of all research and development is paid for by the successful products. A small portion of the sale price of most products goes to research and development. Without research and development, a manufacturer would have a difficult time keeping up with changes in buying habits and changes in technology.

Customer service is an important element of product success. The customer service department does not manufacture a product, and it does not make a profit. It is a cost center that helps the customer feel satisfied with the product and its purchase. Customer service also helps the customer get results if there is any problem with a product. The cost of customer service must come from profits; it is part of overhead. A small amount of the selling price is used to pay for the customer service department. The higher the quality of the manufactured product, the less money is needed to pay for customer service. This is because high-quality products need very little customer service.

Insurance protects the manufacturer from liability, lawsuits, and loss from fire or other causes. The cost of insurance is paid for out of profits. If no claims are made against the insurance, the premiums are lowered somewhat, but insurance is necessary to protect the investment made by the manufacturer or corporation.

Advertising is another cost center. In order to sell products, advertising is usually necessary. Advertising informs people of the product's features and shows them how it is used. It helps generate a need for the product. Advertising may be in print, on radio, or television. Some advertising today appears on computer software and videotape. These media target a specific audience. There are also sales brochures that are printed for some products. Sales brochures are given to prospective buyers. The brochure reminds them of the selling features of the product long after their discussion with a salesperson. There are many other types of overhead that must be paid out of profits. Wages and benefits for all employees make up a large portion of overhead. Lights, heat, and air conditioning are also part of overhead. These costs reduce the actual profit of a manufacturing business. There are "gross profits," which are the total profits, and there are "net profits." "Net profits" are the profits earned after overhead costs have been deducted.

Products are sold at list price. The person selling the product is usually a retailer. The retailer buys the product from the manufacturer or a distributor. The price paid by the retailer is the wholesale price. The difference between the wholesale and retail price is the retailer's profit or mark-up. The retailer also has costs and overhead that must be deducted from the gross profits.

Retailers sometimes find that consumers will not pay the full list price, so they reduce the price to sell the product. Sometimes competition from other products will affect the list price; then the price must be reduced. Demand usually increases as price decreases. The increased sales volume sometimes makes up the difference in profit. This is because manufacturing quantity goes up which reduces the unit cost or cost per product.

If retailers have products on their shelves that are not selling, their capital is tied up in inventory. No profit is made if products are not sold. Retailers make a profit by selling goods and reinvesting part of the money in inventory. This is known as "cash flow." If money does not flow, there is no profit.

Questions Related to Product Cost

1. How great is the difference between the wholesale and retail price of a product?
2. Is all retail income actually profit? What costs or overhead does the retailer have?
3. When a product is manufactured, what part of the cost pays for product research and development?
4. How much of the price is used to pay for customer service? Why is customer service so important today?
5. How does international competition affect the price of a product?
6. Can high-volume production actually reduce the cost of a product at the wholesale and retail end? How does this happen?
7. How does consumer demand affect the price of any product?
8. What is the difference between gross profits and net profits? Where does this money go?
9. What are some ways that a manufacturer or retailer can reduce the cost of a product that is manufactured or sold?
10. What is cash flow? How does it affect the price of a product?

Alternative Strategies for Activity Number: Busecon.005

Instructor can use a lecture and discussion format to deliver the same information concerning product cost. The instructor could also videotape a guest lecture so that it can be used another time. For best results, do the information sheet prior to the guest speaker's visit.

Learning/Performance Checks: Busecon.005

Participation in class discussion and lecture will serve as a learning check.

ACTIVITY NUMBER BUSECON.006

THE VALUE OF A PART

Description:

Student groups are given various manufactured parts to evaluate for the total manufactured cost. Students determine the cost of the raw material and the cost of each operation done to complete the part.

Rationale:

Learning how value is added to raw material through various operations helps the learner understand the costs that make up the price of a product.

Outcomes:

Students will be able to trace the manufacturing operations which add value to a raw material. Students will be able to describe the relationship between manufacturing costs and waste, product cost, and profit.

Tools, Materials, Machines, and Resources:

1. Bame, E. A., & P. Cummings. (1980). Exploring technology. Worchester, MA: Davis Publications.
2. Fales, James, Everett Sheets, Gregg Mervich, and John Dinan. (1981). Manufacturing: A basic text for industrial arts. Bloomington, IL: McKnight Publishing Co.
3. Rudelius, William, W. Bruce Erickson, & William J. Bakula, Jr. (1973). An introduction to contemporary business. New York: Harcourt Brace Jovanovich, Inc. (ISBN 0-15-541641-3)
4. Manufactured parts from your lab, other labs, or manufacturing facilities.

Instructional Strategy:

Students are divided into groups and given the information sheet to read. The groups are furnished with a manufactured part to analyze. Each group then uses the work sheets to estimate the cost of each operation required to manufacture the part. Student groups report their findings to the class and participate in class discussion. The instructor may wish to incorporate this unit into a manufacturing activity in the class.

Safe Practices:

None.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

______ Assertiveness
___x___ Negotiation
___x___ Listening
______ Risk Taking

Change:

______ Personal Adaption
___x___ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications________________________________

Decision Making:

______ Ethical Reasoning
___x___ Logical Reasoning
______ Flexibility

Problem Analysis:

______ Identification
______ Solutions
______ Evaluation
______ Implementation

The Value of a Part

Any manufactured part used to manufacture a product has value. The value begins with the cost of the raw material. As the raw material is processed, each operation performed actually raises the value of the part. There are many expenses that go into each operation. There is the labor required to perform the operation, and there is the cost of the tools and machines needed to perform the operation. When cutters or bits become dull or break, the cost of the tooling must be added to the part value.

If there are close tolerances on the part, then the value of the part goes up quickly. This is because any operation now depends on the operation before it and after it to assure quality and tolerances. When several operations have been done correctly and an error is made, then the workpiece becomes expensive scrap. As the raw material is transformed into a part, every step or operation raises the value of the raw material.

In some cases, parts that are damaged or out of tolerance can be reworked (repaired). This requires more labor and there is no guarantee that the parts can be used. Rework is not an acceptable way of holding tolerances. It is expensive and it reduces the quality of the manufactured product.

Quality is important to controlling costs. Reduced waste and close tolerances mean that the quality increases and costs decrease.

THE VALUE OF A PART

WORK SHEET

Name________________________________ Class_____________ Date______

PART NAME__________________________ MATERIAL_________________

Raw Material Cost_______________________

Operation Number 1 _________________ Cost____________________

Operation Number 2 _________________ Cost____________________

Operation Number 3 _________________ Cost____________________

Operation Number 4 _________________ Cost____________________

Operation Number 5 _________________ Cost____________________

Operation Number 6 _________________ Cost____________________

Operation Number 7 _________________ Cost____________________

Operation Number 8 _________________ Cost____________________

Operation Number 9 _________________ Cost____________________

Operation Number 10_________________ Cost____________________

Total Cost____________________

The finished part is _____ times as valuable as the raw material.

Name________________________ Class____________ Date________

PART VALUE DISCUSSION

1. Were you surprised at the actual value of the finished part? How many times more than the raw material value was the value of your finished part(s)?

2. When you estimated the cost of each operation, did you figure in the cost of overhead?

3. What are some types of overhead that should be figured into the total cost?

4. How much waste is there when a part is ruined after the third operation? How much waste is there after the fifth operation?

5. Can quality control help reduce manufacturing errors? What amount must be added to the part to pay for the quality control?

6. When parts are made poorly, what extra costs can be expected? Will the manufacturer pay more for returned goods? Will there be any additional costs for warranty work?

7. Suppose the raw material does not meet specified standards. If the substandard material is used, how much waste has been generated?

8. Why is it important to work accurately when processing material into parts?

9. If you are an employee in a manufacturing firm, do you think it is your job to eliminate waste and strive for quality? Why?

10. How do you think waste and poor quality would affect your job?

Alternative Strategies for Activity Number: Busecon.006

The instructor could lecture on this topic and use the discussion questions furnished with this activity.

Learning/Performance Checks: Busecon.006

Class activity and discussion sheets monitor learning.

Alternative Strategy for Activity Number: PPC.003

Have students form teams of 3 to 5 members. They will then select a product and analyze its components. Each group will make a list of the parts and materials needed to completely manufacture the product. The teams will then categorize these parts and materials into the following inventories and explain the importance of these inventories in the manufacture of the product.

1. Raw materials.
2. Purchased parts.
3. Work-in-process.
4. Finished parts.
5. Supplies.

The teams will defend their decisions and explain the criteria they used. The instructor will act as the leader and mediator for the teams.

Safe Practices:

None.

Record keeping is an important function of the inventory process. Companies must know at all times what materials are on hand and how many finished products are available for their customers. This also gives adequate time to order additional materials so that they will be available for production when needed. On the other hand, care must be taken not to overstock materials. This can be very costly in the manufacturing process. The ordering, storage, and retrieval of materials in inventory are very critical to the manufacturing system. When materials are needed, they are ordered using a **material requisition** form. The material requisition identifies the type and amount of materials needed, and gives all of the necessary specifications for the materials. The unit cost and total cost would also be listed in the material requisition. The material requisition would also include a **purchase order (P.O.)** number which identifies the order for future reference.

This process may also be done automatically when the inventory level is reduced to a certain point as in the **just-in-time (JIT)** system. This system reduces lead time in manufacturing and decreases the need to keep large amounts of materials on hand. The JIT system may only allow several days from the time the raw materials or parts arrive until they are placed into production, which reduces the amount of inventory on hand. The JIT timing technique is known as **Kanban,** which is a **pull** type system. This exists when the user signals or "pulls" more materials from the supplier. Kanban devices must communicate the need for more materials simply and accurately. Kanban places exact limits on the number or pieces of inventory between the maker and the user and sets forth exact locations for them. The quantities handled are usually small, but are in continuous flow. The **material requirements planning (MRP)** would be the opposite of Kanban. The MRP is a "push" type system where material orders are planned in advance, which when executed, cause work centers to make and push products forward.

Another method for restocking materials is known as **reorder point (ROP)**. This is one of the oldest of the inventory timing approaches. In the **perpetual** system, stock is replenished when it drops to a reorder quantity. This level may be signaled in a number of ways: a two-bin system indicates a reorder when one bin is empty, a level marker might indicate that resupply is necessary or a divider in the supply container may show the point of reorder. In the **periodic** system, reorders are initiated at fixed intervals rather than when stock gets low.

If reorder is not closely maintained, two problems may occur. There may be a shortage of materials on hand, which will cause production to come to a halt, or an overstock may be created. This can become a costly inventory problem. Some companies like to maintain a **buffer stock**, or safety margin of materials on hand to insure that production supply does not fall short. An excessive buffer stock, however, is wasteful and can increase inventory costs.

Human Resources

Human resources is defined as the people who work for any business or industry. Human resources consider their skills, education, and experiences. In many businesses and industries, there may be a department of human resources. This department oversees all activities related to the work force. For example, the human resources department might write the job description that you read in the newspaper. This job description helps management find a person with the appropriate skills, experience and education needed to do the job.

As you look at the human resources of any business or industry, you will see people with many different levels of skill, experience, and education. There will be men and women, people of different races, various age groups, and many different personalities. They are the human resources who get things done. They know their jobs, and they work quickly and efficiently to complete them.

Many tasks are performed by groups. Several people work together to get a job done. These people combine their talents and are able to accomplish more in less time. There is harmony when they combine their knowledge, skills, and experience. People sometimes wonder how people with so many different backgrounds and personalities can work together. The answer is simple: they have a common goal. This goal gives them a purpose within the group. They feel as if they are part of a team and they work together with a single personality.

The needs of any business or industry change as equipment or products change. The business or industry will need new skills, and knowledge. One way to get new skills and knowledge is to hire employees who have finished a training program or graduated from high school or a university. Another way is to send employees to a training program that will give them the skills and knowledge to do the job. A third way to obtain new skills and knowledge is to hire an experienced person from another business or industry. This usually costs more money because most people do not change jobs without a raise in salary or some increase in benefits. Whether new people are hired or current employees are trained, the responsibility for the decision will rest with the human resources department. In fact, if current employees are trained, the human resources department will probably decide who will be trained.

ACTIVITY NUMBER PPC.004

BILL OF MATERIALS AND REQUISITIONS

Description:

A number of different types of materials may be needed to manufacture a given product. The manufacturer must determine what kinds of materials will be needed and how many to order at one time. This exercise will give you some experience in analyzing the components of a product and developing a material list. Students will be divided into teams of 2 to 3 students. Each team will develop a bill of materials for a product and complete a requisition for the materials.

Rationale:

It is important to have an understanding of the concept of a material inventory. Materials to be used for a product must be correctly determined and sufficient stock must be kept on hand to maintain a continuous flow of production.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of maintaining an inventory.
2. Identify and discuss inventory terminology such as ROP, Kanban, JIT, and Buffer stock.
3. Analyze a product or drawing to determine the materials needed for production of the product.
4. Complete a bill of materials for a product.
5. Complete a material requisition.

Questions for Discussion

1. How would you define "human resources"?

2. What are some of the functions of the human resources department in business or industry?

3. Why is it possible for people with diverse backgrounds to work together in groups without problems?

4. If members of a work group cannot get along or work together, what do you think should be done?

5. When the human resources department decides who should be trained, do you think the department will act fairly? Why?

6. What criteria do you think the human resources department will use to decide who should be trained? Do you think the criteria will remain the same for all jobs?

7. What kind of reward should be given to a person who seeks training and educational opportunities on his/her own? Do you think that it is fair to reward such a person when others are not? Why?

8. When a business or industry hires someone with the appropriate skills for more money than other employees are making, what happens to morale?

9. How does the supply of knowledge, skills, or experience affect wages? Can you name some jobs that pay well because the supply of human resources is lower than the demand?

10. What is the value of a business or industry when the human resources are removed?

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Alternative Strategies for Activity Number: Busecon.007

The instructor can present a lecture/discussion on human resources using the discussion questions above, or a human resources guest speaker could be brought into class.

Learning/Performance Checks: Busecon.007

Participation in group activities and written responses to discussion questions will check learning.

ACTIVITY NUMBER BUSECON.008

CONSUMER SATISFACTION

Description:

Students examine consumer rights and safeguards. They apply their learning to products they might produce or sell.

Rationale:

It is the responsibility of any employee to represent products fairly and uphold the quality of the products that are produced or sold.

Outcomes:

Students describe consumer rights and safeguards concerning manufactured products. Students will be able to discuss how a product should be guaranteed, and will describe ways in which it should be advertised. Students will define "warranty" and "advertising" and discuss how these affect consumer satisfaction.

Tools, Materials, Machines, and Resources:

1. Heilbroner, Robert L., et al. (1972). In the name of profit. New York: Doubleday & Company.
2. Herndon, Booton. (1972). Satisfaction guaranteed. New York: McGraw-Hill Book Company. (ISBN 07-028350-8)

Instructional Strategy:

Students read the instruction sheet and discuss its content. They are then divided into groups to evaluate manufactured products and then write a guarantee and develop an advertising plan. If possible, students can use products from the manufacturing lab. Students then do a case study of any product that has a remarkable guarantee and reputation or a product that consumers have complained about. The case study can be done individually or in groups. The case studies could be entered on a word processing system to gain keyboard experience.

Safe Practices:

None.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
__x__ Professional Adaption

Computer:

_____ Operating Systems
__x__ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
_____ Solutions
__x__ Evaluation
_____ Implementation

Student Information Sheet Number: Busecon.008

A customer buys a product because it fits a need. If several products will fulfill the need, the customer buys a product based on advertising, guarantee, quality, and price.

Advertising informs the consumer of the product's qualities and how it works. Some advertisements stretch the claims of a product. This can be misleading and may lure someone into buying a product that will not fulfill the intended need. The government protects the consumer when the advertising is misleading. The government also investigates products whose advertisements stretch the truth or mislead the consumer.

A product's guarantee is a contract between the manufacturer and the consumer. It tells the consumer what will be done if the product breaks or malfunctions. A guarantee may promise to fix or replace a malfunctioning product for 30 days or longer. Some guarantees may last as long as five years, but the length of the contract varies among products and manufacturers.

Some manufacturers have toll-free phone numbers that customers may call if the product breaks or malfunctions. The people who answer these phone calls are called "customer service agents" or "representatives." Their job is to keep the customer happy. People who work in customer service are trained to cope with unhappy people. Those people who work in customer service are very courteous and patient; they are also good listeners. They must know exactly what is wrong before they can satisfy the customer.

If the manufacturer wants a reputation for quality, customers must be satisfied. Unhappy customers do not return to buy additional products. They also tell their friends about the product and why they are unhappy. Word-of-mouth advertising can help or hurt a product. Quality is very important to the product's reputation.

The news media can also affect a product's reputation. There are consumer columns in many newspapers and consumer programs on both radio and television. These programs inform people of defective or dangerous products in the marketplace. They also try to help consumers resolve disagreements with the manufacturer.

Quality is the most important aspect of any manufactured product. Any person working on a manufactured product is responsible for its quality. Any problem that can be eliminated at the manufacturing site will increase the quality of the product and its reputation in the marketplace.

Name________________________________ Class_________ Date_________

Questions for Discussion

1. Can you think of some type of advertising that is misleading? How does the advertising mislead the consumer?

2. What happens when a consumer is not happy with a product? What happens if the product is broken or malfunctions?

3. What is the purpose of a customer service representative? What skills does one need to be a customer service representative?

4. How is the reputation of a product or its manufacturer damaged by poor quality?

5. As an employee in a manufacturing operation, should quality be your responsibility? Could your actions enhance the reputation of the manufacturer or its products?

6. How does the news media affect the reputation of a product?

7. How would you define the term "guarantee"?

8. What is the purpose of a guarantee? Can it motivate a consumer to buy the product?

Name____________________________ Class______________ Date_______

Consumer Satisfaction

Case Study Assignment

Select a product found in Consumer Reports and do a case study of how the product got its reputation. Be sure to get your instructor's approval for the product you have selected. To do your case study, you will need some articles about the product; a sample of its advertising and its guarantee. You may also want to see what type of customer service is offered. Submit a rough draft to your instructor and rewrite your case study if necessary. Sum up your findings in a report to your class.

The product I have selected is:________________________________

Instructor's approval of case study product:__________________

Alternative Strategies for Activity Number: Busecon.008

Students can research a specific product in Consumer Reports and report on the differences and the comments made concerning each brand.

Learning/Performance Checks: Busecon.008

Responses to questions and completion of the case study will check learning.

PRODUCT AND PROCESS CONTROL

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UNIT GOALS

1. Define product and process control and explain the importance of each. (PPC.001)

2. Define the roles of designers and engineers in the development of a product. (PPC.001, .002)

3. Design a product for a manufacturing process. (PPC.001)

4. Explain the importance of a process design in a manufacturing system. (PPC.002)

5. List the major factors in process planning and develop a process plan for manufacturing a product. (PPC.002)

6. Identify and explain the three main types of manufacturing systems. (PPC.002)

7. Estimate the production time for a part to be manufactured. (PPC.002)

8. Explain the importance of inventory control. (PPC.003)

9. Complete a bill of materials and material requisition sheet and explain the importance of each. (PPC.004)

10. Explain how materials are received, stored, and retrieved in the inventory process. (PPC.005)

11. Identify and explain the main factors involved in determining plant layout for producing a product. (PPC.006)

12. Design and develop a flow diagram for producing a product. (PPC.007)

13. Discuss the importance of departmental integration in the manufacture of a product. (PPC.007)

14. Explain the main factors which have an effect on work-in-process. (PPC.008)

15. Name several types of material handling systems and explain their functions in a manufacturing system. (PPC.009)

16. Discuss several factors which must be considered in the control of work-in-process. (PPC.010)

17. List several types of inspection procedures and explain why they are important in production. (PPC.011)

UNIT GOALS
(continued)

18. Compare and contrast some of the computer controlled operations used to manufacture products. (PPC.012)

19. Discuss the impact of automation on a manufacturing system. (PPC.013)

20. Identify several types of integrated manufacturing systems and discuss their importance in the production of a product. (PPC.013)

21. Discuss the importance of product identification, packaging, and storage. (PPC.014)

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ACTIVITY NUMBER PPC.001

PRODUCT DESIGN

Description:

This is an exercise to give the students an understanding of the importance of product design in the development of a manufacturing system. The students will develop a list of factors which need to be considered in the design of a product. Students will break up into teams of 3 to 5 members and analyze the design of one or more products to determine why these products might be feasible for production. Students will then design a simple product for manufacture.

Rationale:

It is important to determine the feasibility of manufacturing a product before the actual processing begins. A careful study of product design factors could make the difference in the success or failure of the product.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Define the roles of designers and engineers in the development of a product.
2. State four of the main factors that a company must consider when selecting a design for a new product, and explain the importance of these factors.
3. Explain the importance of product design as used in a manufacturing system.
4. Select a product, analyze its design and determine the factors which make it feasible for production.
5. Design a simple product for manufacture.

Tools, Materials, Machines, and Resources:

1. Fales, J., Mervich, G., Sheets, E., & Dinan, J. (1986). Manufacturing. Mission Hills, CA: Glencoe Publishing Company. (pp. 87-102)
2. Wright, R. Thomas. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company. (pp. 149-177)
3. Technology education: Manufacturing technology (pamphlet: curriculum information). (1987). Grand Forks, ND: North Dakota State Board for Vocational Education.
4. Manufacturing systems explained (video series--inputs and resources, processes, controls and outputs). (1988). Mission Hills, CA: Glencoe Publishing Company.
5. Design for quality (film showing design, manufacture, and testing of tires). Modern Talking Picture Service.
6. Developing products for manufacturing (filmstrip with audiotape). Muncie, IN: Ball State University, Manufacturing Forum, Dept. of Industry and Technology.
7. Products which are to be evaluated by the student.
8. Checklist forms developed by the instructor, which may be used to analyze products.
9. Thumbnail Sketches sheet and Final Product Design sheet (included for this unit).
10. Computer software programs for product design.

Instructional Strategies:

The students will be exposed to the design factors of product control by means of lecture, audiovisual materials, and reading assignments. Product design factors will be analyzed by group interaction. Teams will be formed to determine product design evaluations and production feasibility. Teams will then design a product for manufacture.

Safe Practices:

Careful handling and/or disassembly of products which are being analyzed.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

__x__ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
______ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications ____Product Design__________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Product ideas must be developed to meet the needs of production, as well as the needs of the consumer. Product designers must give consideration to a number of different variables before starting the design process. The design team works closely with the engineer to develop a procedure which will best solve the design problem. The design team must first collect ideas and then use the **brainstorming** process to initiate product designs. A number of ideas are written down during this process. The design team then chooses the best ideas and begins by sketching these ideas on paper. **Thumbnail sketches** or small, quick sketches are first used to illustrate the ideas. Then, a more detailed drawing, called a **rendering**, is completed to show all of the details of the product. Much of the design process may be done using a **CAD** system, or **computer automated design**, which may be faster and more efficient. These design activities must meet several goals for the product to be successful. The product must be:

1. Useful to the consumer.
2. Profitable to manufacture.
    a. Producibility
    b. Testability
3. Competitive in the marketplace.

These three goals might be better known to the designer as **FUNCTION, MANUFACTURE, AND SALES.**

The kinds of materials used in the product may be very critical to its function. If the product must withstand such things as stress, strain, fracture resistance or wear resistance, then **material properties** become an important factor of design. This will also have an effect on the **cost of materials,** as well as the **economic use of material** in the product that is to be manufactured. Size, shape, complexity, and surface finish of the product are all critical factors in the manufacturing process. The size of the product must be considered to determine the cost of the material from which the product will be made. The shape of the product will have an effect on several things in the manufacturing process. The shape will determine the strength or the part, relative to the amount and type of material being used. A given part made of steel, for example, may be stronger than if made of wood. However, there would be a distinct difference in the weight factor of the two parts. Whether the part was solid or hollow would also be a factor, but strength might be a concern in this case. The shape would also affect such things as the size of machines needed to make the part, the method used to transfer the part from one area to the next, and the types of fixtures needed to hold the part.

The complexity of the product must be considered for the number of operations needed to manufacture it, as well as the labor hours required to finish the part to the desired specifications. Additional operations would also be needed if the product required a high level of surface finish.

Product liability has become another major concern in the design of the product. Manufactured products must be safe for consumer use. Much time must be invested in the testing of products to insure that product failure does not occur and cause injury to the consumer. The **efficiency of the manufacturing process** is also a critical factor of the design process. The first consideration is the type of manufacturing system to be used, which will be discussed in PPC.002 on process design. Once again, the size, shape, complexity, and surface finish of the product will be critical factors in the size and accuracy of the machines and fixtures to be used, as well as the method of transfer needed to move the part through the manufacturing processes. **Interchangeability** of parts will require closer tolerance limitations and more extensive design considerations. This would increase processing time and result in a higher production cost. Some of the features of the product may be designed to meet the needs of the existing **manufacturing resources.**

The last critical factor of design is the selling price of the finished product. There must be a margin of profit included in the selling price of the product so that the manufacturing process can continue at a profitable level. The selling price must include all of the costs of manufacturing which were required to meet the design specifications of the product, and at the same time be affordable for the consumer. The design must be appealing to the buyer and must also be worth the selling price.

After the initial design sketches have been completed, **mock-ups** must be made to show a three-dimensional view of the product. The mock-ups and the design sketches are then sent to the product engineer, who figures out all the details of the product. The engineer must make sure that the product works. The engineer must also make the final decisions regarding size, shape and processing requirements. When these decisions have been made, a drafter makes detailed drawings of the part so that prototypes can be made and tested to determine final approval of the product for manufacturing. After the final decision has been made as to which product will be manufactured, the product can be released for production planning.

We can see why it is important to have close control during the design stage of the manufacturing process. The product, as well as the process, are important elements of the design stage of product and process control.

Student Activity Sheet: PPC.001

Students will form teams of 3 to 5 members. The teams will be given a design problem (an example of a design problem is included in the student materials). The students must remember that there are a number of things to consider when developing a design for a product. Such things as size, shape, type of material, cost, ease of manufacture, complexity of design, tolerance requirements, quantity and assembly requirements are all important factors of production.

The teams will complete the following activities:

1. Use the brainstorming technique to generate some ideas which will meet the guidelines of the design problem.

2. Use thumbnail sketches to put the team's ideas on paper. These are just rough sketches of different ideas to form a series of pictures. Use Thumbnail Sketches sheet (see PPC.001/Fig. 1) included in this unit.

3. Combine several of the best sketches as determined by the team and refine the design into one final product sketch. Use Final Product Design sheet (see PPC.001/Fig. 2) included in this unit.

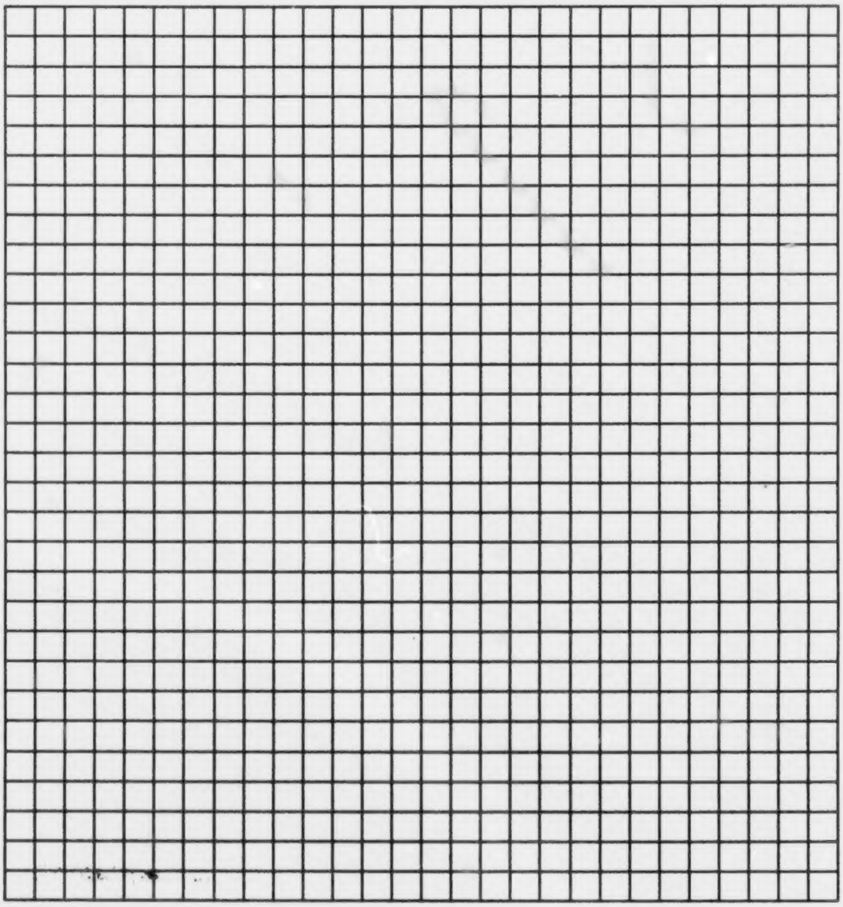
4. Present the product design to the other teams and discuss positive and negative concerns about the design relative to design specifications and manufacturing feasibility.

After each of the teams has given its presentations and has discussed the product designs, the team members may need to make some changes in their final product sketch. The next step is to complete a more detailed drawing. These "renderings," as they are called, should be drawn on graph paper using a pencil, ruler, and triangles and t-square if needed. These drawings should be dimensioned and should include several different views to give a clear understanding of the product design. They should include front, side, and top views of the product. When the drawings have been completed, they should be submitted to the instructor for evaluation.

The final phase of this product design activity is to make mock-ups of the product. The teams may use heavy paper or cardboard for your mock-up. The mock-up is a t0hree-dimensional model of the product. The mock-up should be made full size to give a better idea of the finished size. Some of the mock-ups that are developed in industry must be scaled down because the finished products may be of a very large size. When the mock-ups are completed, they will be presented to the other teams. The mock-ups should then be submitted to the instructor for evaluation.

The teams may then vote to determine which of the designs would be most suitable for production. They should also discuss the criteria which were used to select the design.

THUMBNAIL SKETCHES



PPC.001/Fig. 1. Thumbnail Sketches
(PRODUCT AND PROCESS CONTROL, PPC.001)

FINAL PRODUCT DESIGN

PPC.001/Fig. 2. Final Product Design
(PRODUCT AND PROCESS CONTROL, PPC.001)

Design Problem

You have been contacted by a company to develop a new product for them. The company sells cassette tapes and compact discs. The company is projecting a high volume of sales in compact discs for several years. The marketing department has determined that a product that stores, organizes, and displays compact discs would be a profitable venture.

Marketing research shows that most compact disc players are usually located on shelves in stereo cabinets made of wood. Compact disc players usually come in black, black with a silver metal face, or wood grain trim.

The company would like a drawing and mock-up of the product design for its approval. The company will be reviewing product designs from a number of other sources.

The design specifications are as follows:

1. The compact disc organizer should be able to hold at least 20 disc containers which measure 5" high, 5 1/2" wide, and 3/8" thick.
2. The labels are located on the 5 1/2" edge and should be exposed in plain view in the organizer.
3. The organizer should be designed so that it is free-standing and can be located on a book shelf or a table top.
4. The organizer can be made out of a variety of materials.
5. The design should be appealing to the eye and complement stereo equipment and furniture.

Design considerations:

1. Minimize the number of parts.
2. Easy and fast to assemble (e.g., snap together rather than using fasteners).
3. Eliminate sub-assemblies when possible.
4. Assemble from a base upward without requiring the unit to be rotated.
5. Specify close tolerances only if needed for proper function.
6. Do not overdesign.

Activity #1

The students will be asked to evaluate a number of different products. These products could be brought in by the students or supplied by the instructor. The students would use checklists to evaluate the various elements of design. This would be done in teams of 3 to 5 students. This activity might include the development of product evaluation questionnaires which would be given to other students in the school or to another class. The teams would then make a production feasibility list for each product and determine which ones would be best for manufacture.

Activity #2

Have students work in teams to evaluate the product design process of a local company. This could be set up as a field trip or teams could interview personnel from a company they are familiar with. The teams would develop a list of the design elements used by that company and present this information to the group. A discussion of design techniques and product evaluation could then be carried on among the teams.

Learning Check Sheet: PPC.001

Complete the following:

1. A group process in which a variety of ideas are formulated for a design problem is known as ______________________

2. ___________________ are small, quick sketches used to give an initial illustration of an idea.

3. Name three goals which must be included in design activities for a product to be successful.

   A.
   B.
   C.

4. Name five of the factors that a company must consider when selecting a design for a new product.

   A.
   B.
   C.
   D.
   E.

5. A three-dimensional model of a product idea is known as a

   ____

Discuss the following:

1. Define the roles of designers and engineers in the development of a product.

2. Explain the importance of product design as used in a manufacturing system.

3. Explain why selling price is an important factor in the design of a product to be manufactured.

Learning Check Sheet Answer Key: PPC.001

1. Brainstorming

2. Thumbnail sketches

3. A. Useful to the consumer
   B. Profitable to manufacture
   C. Competitive in the marketplace

4. A. Function
   B. Cost
   C. Size
   D. Material type
   E. Quantity
   (additional answers)
   F. Shape
   G. Tolerance
   H. Ease of manufacture
   I. Product safety
   J. Complexity of design

5. Mock-up

Learning/Performance Checks: PPC.001

The instructor will observe and evaluate the students during their design activities, both individually and as team members.

The instructor will evaluate the thumbnail sketches, finished drawings and mock-ups. Consideration must be given to the amount of involvement each individual student had in the completion of each of these activities.

ACTIVITY NUMBER PPC.002

PROCESS DESIGN

Description:

This is an exercise to give the students an understanding of the importance of process design in the manufacturing system. The students will develop a list of factors which need to be considered in the design of a process for manufacturing a product. Students will break up into teams of 3 to 5 members and analyze the design of a process needed to manufacture a product. The teams will then design and lay out the manufacturing process plan.

Rationale:

It is important to determine the efficiency of a manufacturing process before a product has been approved for production. It must be determined whether a company has the proper facilities to manufacture the product. An effective process can save time and money in the manufacture of a product.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Define the roles of designers and engineers in the development of a process needed to produce a product.
2. Explain the importance of process design as used in a manufacturing system.
3. Name and explain the importance of five of the factors that a company must consider when developing a process plan for a manufacturing system.
4. Name and explain the difference between the three types of manufacturing systems.
5. Analyze the design of a process plan and determine its effectiveness for manufacturing a product.
6. Complete a process plan sheet for manufacturing a product.

Tools, Materials, Machines, and Resources:

1. Fales, J., Mervich, G., Sheets, E., & Dinan, J. (1986). Manufacturing. Mission Hills, CA: Glencoe Publishing Company. (pp. 87-102)
2. Wright, R. Thomas, (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company. (pp. 149-177)
3. Technology education: Manufacturing technology (pamphlet). (1987). Grand Forks, ND: North Dakota State Board for Vocational Education.
4. The New Engineers (film about the work of engineers in product and process design). St. Petersburg, FL: Modern Talking Pictures Service.
5. Basic Elements of Production (film on steps of the production process). Ann Arbor, MI: University of Michigan Audio-Visual Education Center.
6. Product or drawing of the product that is to be manufactured.
7. Flow Process Chart, Process Sheet, and Product Cost Estimate Sheet (included in this unit).

Instructional Strategies:

The students will be exposed to the design factors of process control by means of lecture, audio visual materials and reading assignments. Process design factors will be analyzed by group and interaction and problem-solving activities. Teams will be formed to determine process design evaluations and production feasibility. Teams will then complete a process planning activity to be used in the manufacture of a product.

Safe Practices:

Follow general shop safety rules when using shop facility to review processing operations needed to manufacture a product.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

__x__ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

The processes used in the manufacture of a product are an important part of the design process. Product designers must give much thought to the various operations needed to complete a product. They must consider the number of operations required, as well as the type of facilities and equipment needed for the manufacturing process. The designer must work closely with the manufacturing engineer to determine whether the product is suitable for production. They must also determine the most efficient and economical ways to produce the product. A **process plan** must then be developed. The process plan lists all the different operations needed to complete the product from start to finish and shows a logical sequence in which these operations are to be completed. The process plan may also show the number of hours needed for each of the operations to be performed, including setup time, inspection, and transfer operations.

Several factors must be considered in the processing of a product to determine whether it will be profitable to manufacture. The first is the **type of manufacturing system** which will be needed to produce the product. The existing manufacturing system may already be set up for the type of operations needed for the product or may be adapted with a a few minor changes. If the system requires extensive changes, it may not be economical to manufacture the product. Large-scale changes in a company's facilities can be very costly and time consuming. The new product may require one of three types of systems. **Custom** manufacturing, such as tool and die, would be suited for a small number of parts having a high degree of accuracy. **Intermittent or job** manufacturing, such as blow molding several different plastic bottles, might be more suitable for a product made in a variety of sizes and shapes. **Continuous or line** manufacturing, such as the stamping of parts of the production of plywood, would be ideal for making a large number of parts which have a less complex design.

The **number of parts** to be manufactured will be proportional to the selling price of the finished product. It would therefore be more economical to produce a larger number of parts of a given design. The **tolerance** requirements will be one of the factors in determining the types of machines, tools and fixtures needed to produce the parts, as well as the level of quality control needed to meet design specifications. A high level of accuracy in the production of a product will require more expensive equipment, more time in precision finishing and a higher level of quality control. This may greatly increase the time and cost for manufacturing a product. It is apparent then, that the types of **machines, tools, and fixtures** are all important factors in the development of the process plan, as well as the design features of the product. The **size and shape** of the parts, and the **type of material** from which they will be made, are also considerations for facilities and equipment. A very complex part, or one made of special materials, may require a number of additional steps in the operations needed to complete the finished part. The **surface finish** requirements is another factor which might require special finishing equipment and much additional time. The **personnel** requirements must also be considered. The skill level and training requirements of the workers are an important part of the manufacturing process.

In the manufacturing systems of today, emphasis should be placed on several factors. Continuous Flow Manufacturing (C.F.M.) might be profitable, since it requires zero setup time, or at least minimal change-over time, and balanced operations. The product might also be started down through the processing sequence with no stopping of queue points. Statistical Process Control (S.P.C.) should be used on-line wherever possible, with no batch inspection points. Production time may also be decreased by minimizing the through-put time. Care should also be taken in the design stage so that non-value-added operations are kept to a minimum.

After the process plan has been completed, it will then be necessary to review the existing manufacturing facilities to determine if any changes need to be made. Process design is an important part of process control in the manufacture of a product. Efficient and economical processing of the product will be determining factors in profitability and maintaining a competitive status in the marketplace.

Student Activity Sheet: PPC.002

Students will form teams of 3 to 5 members. The teams will be given a prototype product or a dimensioned drawing of a product for which they must develop a process plan which illustrates the sequence of operations required to manufacture the part. The product developed for the design problem in Activity .002 may be used for this exercise. The process plan will be developed for the product to be manufactured in the school shop. Keep in mind that only the machines and fixtures in the school shop will be available for processing the product.

The following factors should be considered when developing the process plan:

1. Type of manufacturing system.
2. Kind of product.
3. Type of material to be used.
4. Size and shape of product.
5. Number of parts to be produced.
6. Machines to be used.
7. Tooling requirements.
8. Jigs and fixtures to be used.
9. Tolerances to be held.
10. Surface finish requirements.
11. Material transportation.
12. Setup and processing time.
13. Product inspection.
14. Product storage.

The students will be given an orientation to the school shop facilities before they begin the actual process planning exercise. If necessary, the instructor will give a full explanation of the facilities and equipment in the shop. The instructor may also have to give demonstrations of the various operations which would be required for the product, if it were to be manufactured. The students should have a good understanding about the use of each machine and the tools and fixtures required for various operations in processing parts. An overview of time requirements for these operations should be discussed at the same time.

Each of the teams will use the Process Planning Sheets (see PPC.002/ Fig. 3) included in the unit materials to record the necessary information. The shop may need to be used during the planning process to help students visualize the operations needed to complete the product.

PPC.002/Fig. 3. Process Sheet
(PRODUCT AND PROCESS CONTROL, PPC.002)

PROCESS SHEET								PART NO.			
PART NAME								DATE			
		QUANTITY									
		MATERIAL									
		HEAT TREAT									
OPERATION	MACHINE	RATE	HRS EA	HRS	COST	HRS	COST	HRS	COST	HRS	COST
	SUB TOTAL										
	SALES COMM.										
	GRAND TOTAL										
SHEET_OF_	COST PER EA										

415

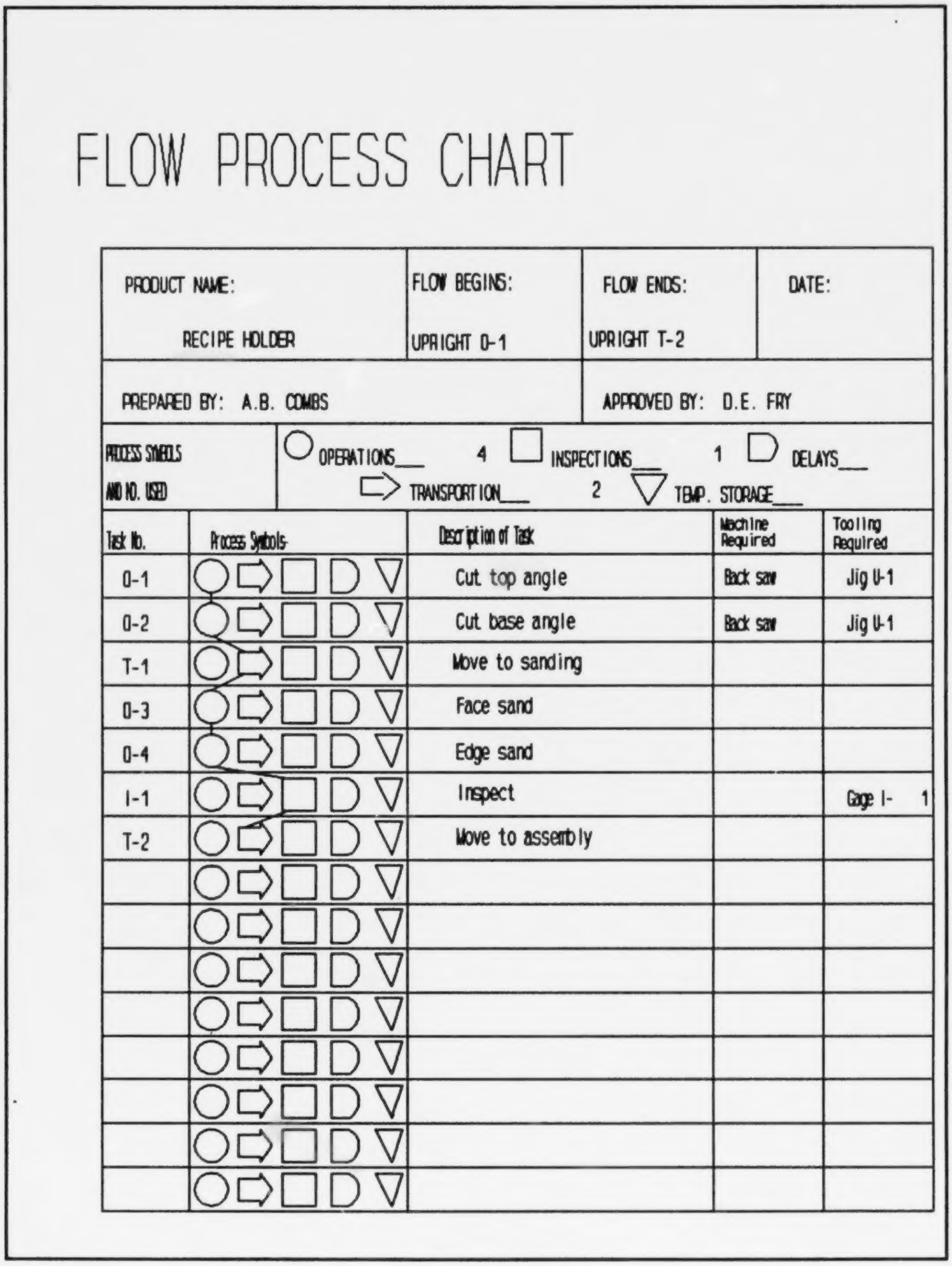
416

The teams will complete the following activities:

1. Analyze the prototype product or dimensioned drawing and make a list of the operations needed to complete the part.
2. Review the sample Flow Process Chart provided (see PPC.002/ Fig. 4), and then determine the first operation that must be performed to make the product. Record this information on the blank Flow Process Chart (see PPC.002/Fig. 4A) provided for this activity.
3. List the task number and darken the appropriate symbol in the process symbols column.
4. In the next column, write a short description of the operation be used.
5. Estimate and document the time required to perform the operation. Review the Sample Product Cost Estimate sheet (see PPC.002/Fig. 5), and then use the blank sheet (see PPC.002/ Fig. 5A) to record your information.
6. In the last two columns, list the machines, tools and fixtures used to complete the operations.
7. Continue this procedure for the second and each additional operation used to process the product, recording the required information in the appropriate column. Be sure to list inspection points and transfer points while processing the part.
8. Be prepared to discuss your production sequence for the part you are manufacturing.

The teams will then discuss their flow process charts with the entire group and justify their process sequences. The group may then decide on the best flow process for manufacturing the product. A labor rate may then be applied to the processing time for the completed product and a labor cost calculated for all the operations required. The process charts should then be submitted to the instructor for evaluation.

Discuss the need to plan and communicate the product manufacturing sequence. Discuss the importance of product flow and sequence of operations, as well as the role of jigs and fixtures needed during the production process. Discuss the importance of the team concept between the designer, the engineer, and the production personnel to make the process more efficient, more accurate and safe for the production personnel.



FLOW PROCESS CHART

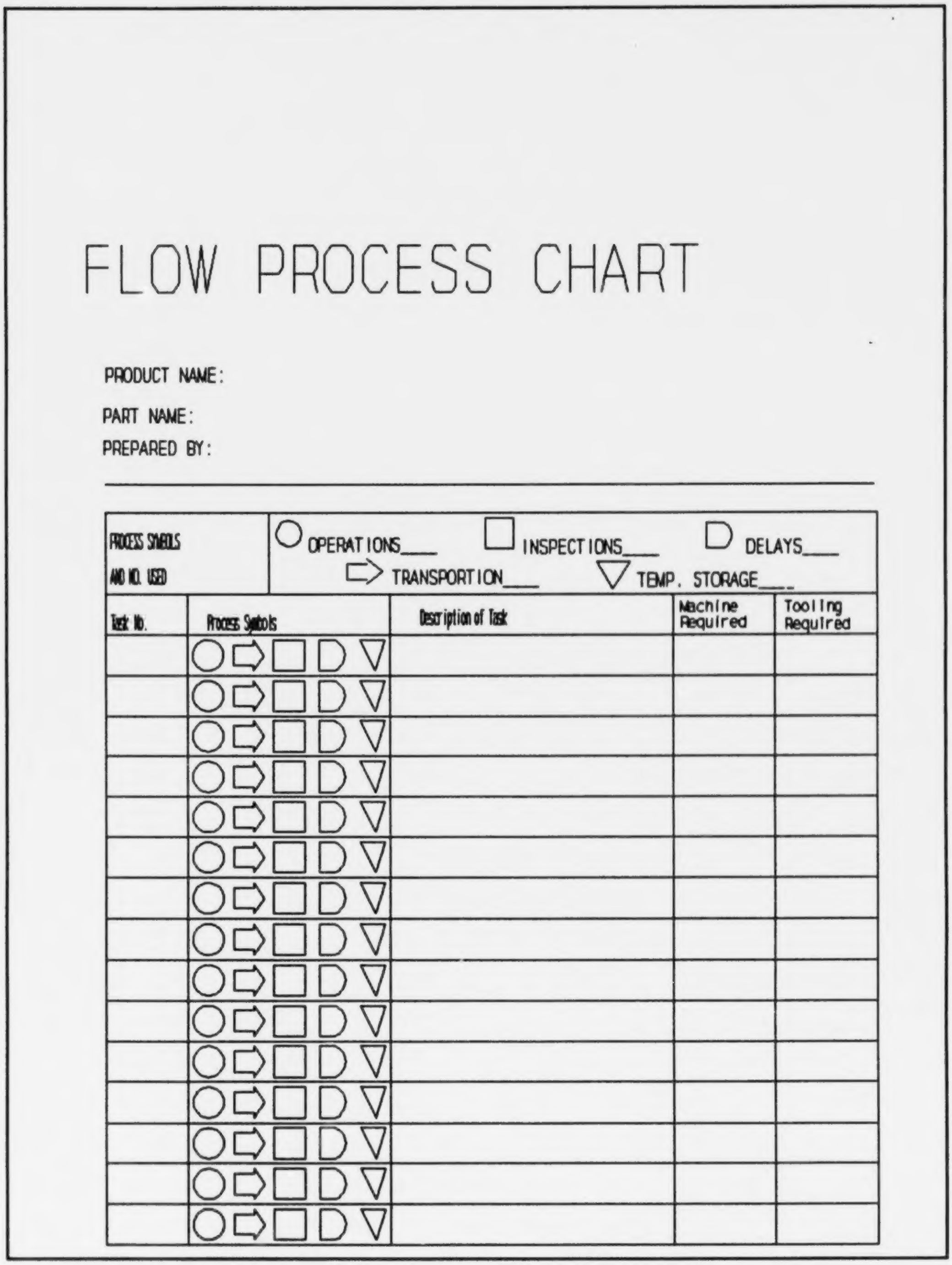
PRODUCT NAME: RECIPE HOLDER	FLOW BEGINS: UPRIGHT O-1	FLOW ENDS: UPRIGHT T-2	DATE:

PREPARED BY: A.B. COMBS	APPROVED BY: D.E. FRY

PROCESS SYMBOLS AND NO. USED: ○ OPERATIONS 4 □ INSPECTIONS 1 D DELAYS ___ ⇨ TRANSPORTION 2 ▽ TEMP. STORAGE ___

Task No.	Process Symbols	Description of Task	Machine Required	Tooling Required
O-1	○ ⇨ □ D ▽	Cut top angle	Back saw	Jig U-1
O-2	○ ⇨ □ D ▽	Cut base angle	Back saw	Jig U-1
T-1	○ ⇨ □ D ▽	Move to sanding		
O-3	○ ⇨ □ D ▽	Face sand		
O-4	○ ⇨ □ D ▽	Edge sand		
I-1	○ ⇨ □ D ▽	Inspect		Gage I- 1
T-2	○ ⇨ □ D ▽	Move to assembly		
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			

PPC.002/Fig. 4. Sample Flow Process Chart
(PRODUCT AND PROCESS CONTROL, PPC.002)



FLOW PROCESS CHART

PRODUCT NAME:

PART NAME:

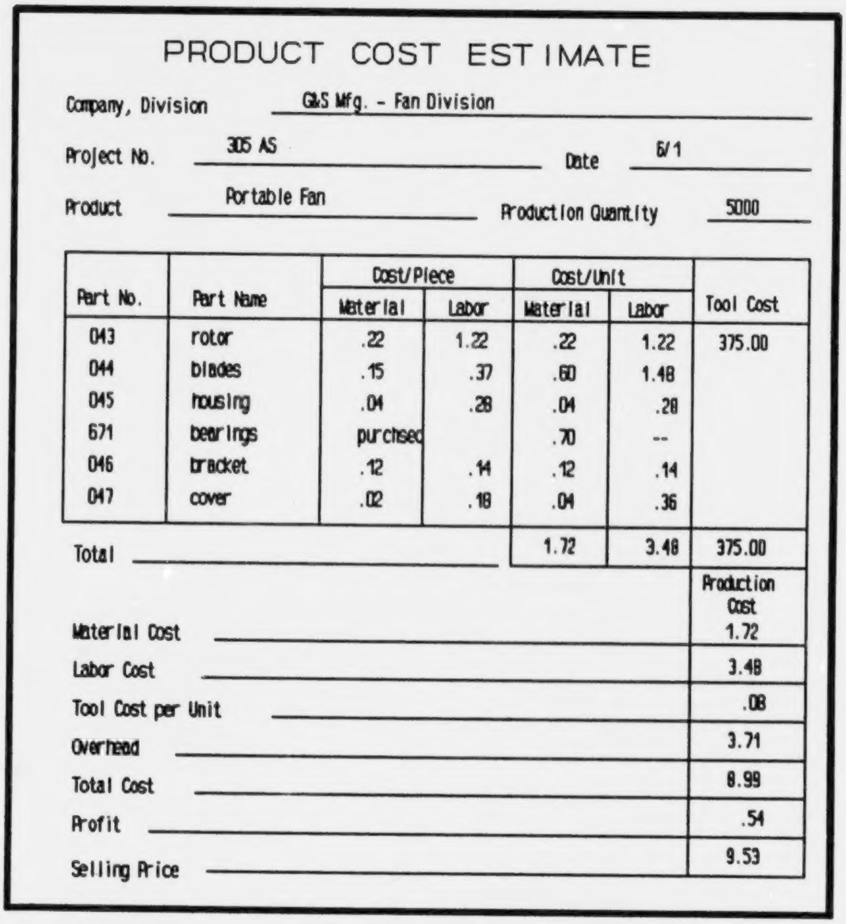
PREPARED BY:

PROCESS SYMBOLS AND NO. USED	○ OPERATIONS___ □ INSPECTIONS___ D DELAYS___ ⇨ TRANSPORTION___ ▽ TEMP. STORAGE___

Task No.	Process Symbols	Description of Task	Machine Required	Tooling Required
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			

PPC.002/Fig. 4A. Flow Process Chart
(PRODUCT AND PROCESS CONTROL, PPC.002)

This is how G&S Manufacturing figured the price of a portable fan. Note the reasonable profit they expect to receive on each fan.



PRODUCT COST ESTIMATE

Company, Division G&S Mfg. - Fan Division

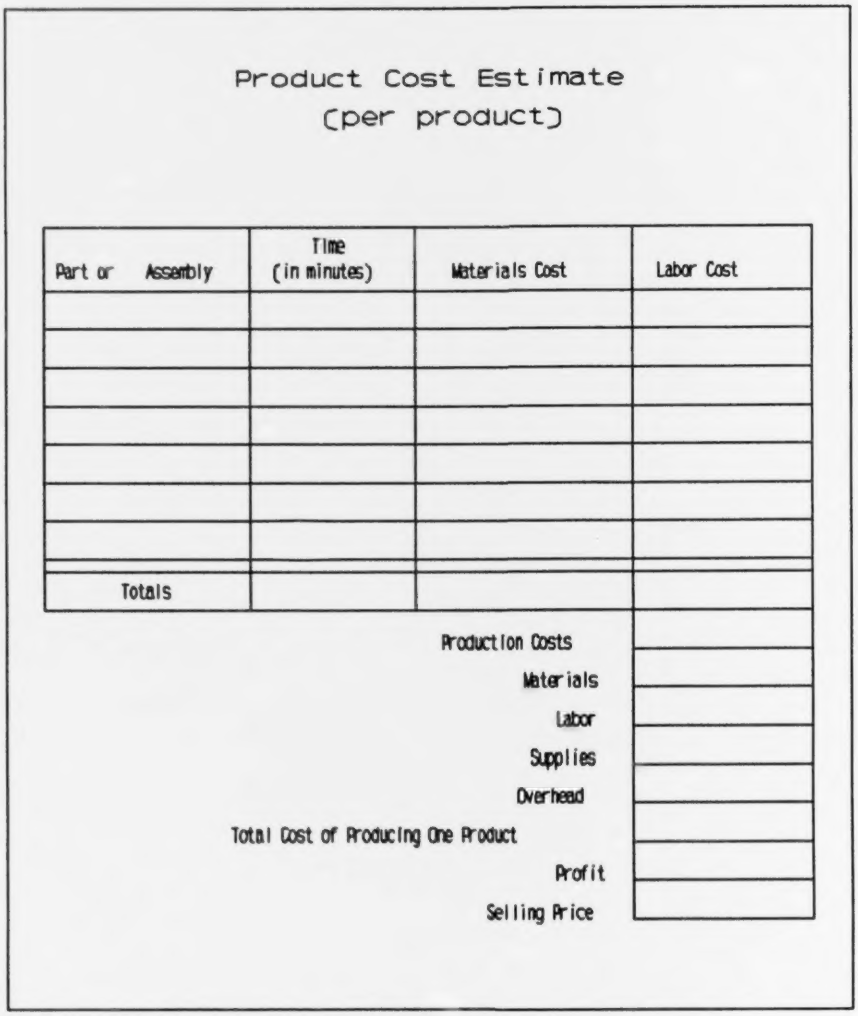
Project No. 305 AS Date 6/1

Product Portable Fan Production Quantity 5000

Part No.	Part Name	Cost/Piece		Cost/Unit		Tool Cost
		Material	Labor	Material	Labor	
043	rotor	.22	1.22	.22	1.22	375.00
044	blades	.15	.37	.60	1.48	
045	housing	.04	.28	.04	.28	
671	bearings	purchsed		.70	--	
046	bracket	.12	.14	.12	.14	
047	cover	.02	.18	.04	.36	
Total				1.72	3.48	375.00

	Production Cost
Material Cost	1.72
Labor Cost	3.48
Tool Cost per Unit	.08
Overhead	3.71
Total Cost	8.99
Profit	.54
Selling Price	9.53

PPC.002/Fig. 5. Sample Product Cost Estimate
(PRODUCT AND PROCESS CONTROL, PPC.002)



Product Cost Estimate
(per product)

Part or Assembly	Time (in minutes)	Materials Cost	Labor Cost
Totals			

Production Costs	
Materials	
Labor	
Supplies	
Overhead	
Total Cost of Producing One Product	
Profit	
Selling Price	

PPC.002/Fig. 5A. Product Cost Estimate
(PRODUCT AND PROCESS CONTROL, PPC.002)

Estimating Time and Cost

As an additional activity, the teams could transfer the flow chart information to the process sheet and record the time in hours that was estimated to complete each operation. A labor rate may be assigned and a total cost calculated for the job.

Alternative Strategies for Activity Number: PPC.002

Activity #1

Have students evaluate and contrast the three different types of manufacturing systems. This activity should be done in teams of 3 to 5 students. Using one or more products or drawings, have the teams determine which system would be best to use for their product and list the sequence of operations needed to complete the finished part. Have the teams compare the system operations for their products and discuss why some systems are more suitable for certain types of products. Also discuss such things as facilities, cost effectiveness, efficiency, time, and accuracy.

Activity #2

Have students work in teams to evaluate the process design of a product which might be used by a local company. This could set up as a field trip or teams could interview personnel from a company they are familiar with. The teams would develop a list of process design elements used by that company and present this information to the group. The teams could then become involved in a discussion of design techniques and process evaluation.

Learning Check: PPC.002

Complete the following:

1. A listing of a logical sequence of all the different operations needed to complete a product from start to finish is called a ________________________.

2. Name five of the factors that a company must consider when developing a process for manufacturing a product.

   A.
   B.
   C.
   D.
   E.

3. The type of manufacturing system used when stamping out a large number of the same kind of parts is known as ________________________.

4. A high level of ____________________ in the production of a product may require more expensive equipment, more time in finishing and closer attention to quality control.

5. The ________________ and ________________ of the workers are an important consideration in the manufacturing process.

Discuss the following:

1. Define the roles of designers and engineers in the development of a process plan for manufacturing a product.

2. Explain the importance of process design as used in a manufacturing system.

3. Name and explain the differences between the three types of manufacturing systems.

Learning Check Answer Key: PPC.002

1. Process plan

2. A. Type of manufacturing system
   B. Machine requirements
   C. Tooling requirements
   D. Jigs and fixtures to be used
   E. Tolerances to be held
   (additional answers)
   F. Size and shape of parts
   G. Number of parts to be made
   H. Surface finish requirements
   I. Type of material to be used
   J. Personnel requirements
   K. Transfer of parts

3. Continuous or line

4. Accuracy

5. Skill level and training requirements

Performance Check: PPC.002

The instructor will observe and evaluate the students during their process design activities, both individually and as team members.

The instructor will evaluate the completed process flow charts. Consideration must be given to the amount of involvement each individual student had in the completion of each of these activities.

ACTIVITY NUMBER PPC.003

INVENTORY CONTROL

Description:

All manufacturing processes require some type of inventory system for products. This exercise will help the students to understand the different types of inventory control and the effect these control systems have on the processing of a product. Inventory control occurs at the beginning, middle, and end of the manufacturing process. We will take a look at the importance of control at these various stages. Students will discuss the different inventory control processes and review some of the forms used to assist in this operation. Students will form panels of 5 to 6 members. Each panel will analyze a product or drawing and determine which inventory system or systems would best be used in the manufacture of the product.

Rationale:

Inventory plays an important role in the product and process control of manufacturing. It is important that to understand the various stages of inventory control and their relationships to the manufacturing process. Raw materials and parts are necessary elements for the continuation of production. Their prompt arrival and processing keeps the manufacturing operations flowing continuously.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of inventory control.
2. Identify and explain three main types of inventory systems.
3. Explain the importance of inventory control for the following: Raw Materials, Purchased Parts, Work-in-Process, Finished Parts and Supplies.
4. Analyze a product or drawing and determine the type or types of inventory systems that might be appropriate for use in manufacturing a product.

Tools, Materials, Machines and Resources:

1. Fales, J., Mervich, G., Sheets, E., & Dinan, J. (1986). Manufacturing. Mission Hills, CA: Glencoe Publishing Company.
2. Fogarty and Hoffman. (1983). Production and inventory management. Cincinnati: South-Western Publishing Company.
3. Schonberger and Knod. (1988). Operations management. San Diego: Business Publications, Inc. (pp. 233-433)
4. Schonberger, Richard J. (1987). Just-in-time production (video tapes on inventory control).
5. Product or product drawing to be used for inventory control.

Instructional Strategies:

The instructor will lecture about the importance of inventory control and show a video on inventory systems. Types of inventories will be discussed and examples given. After the students have analyzed products, the instructor will direct panel groups in discussion about the application of inventory systems in the manufacture of a product.

Safe Practices:

There are no safety hazards in this unit of study.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Inventory control is essential for maintaining a continuous flow of materials through a manufacturing system. **Inventory** is a list of the amounts of materials owned by a company. All materials are identified for a specific use or purpose and must be used wisely. **Inventory control** is a method for making sure that this is done. Inventory control involves all the procedures necessary to keep track of all the materials that are used by the company. Much of this may be done by computer.

There are several different types of inventories which may be used in a manufacturing system. These can be categorized into five main areas:

1. Raw materials.
2. Purchased parts.
3. Work in process.
4. Finished products.
5. Supplies.

Raw materials are all those materials which will be processed during manufacture. These materials are all vital for maintaining a continuous operation. If the company runs out of materials, parts cannot be made, and production must come to a halt. This type of "down time" is very costly to a manufacturing system. **Purchased parts** are all the hardware accessories and ready-made parts that are bought from another manufacturer. These parts are used in production and will become part of the finished product. When products are being built during production, but are not finished, they are known as **work in process.** This would include any work that is at a stage of production between raw materials and the finished product. **Finished products** would then be any of the goods that have already been made. The manufacturer must keep a close accounting of exactly how many products are finished so that accurate production records can be maintained. Many of these finished products must be stored before they are shipped to the customer. The last area which must be considered for inventory is **supplies.** Some materials, such as paint, glue, abrasives and solvents, must be used to assemble parts in the manufacture of the product. These supplies must be kept on hand for use in the various processes necessary to complete the product.

Several types of inventory systems may be used to keep track of these different kinds of materials. The inventory system to be used by a company would be one which would have materials on hand when they are needed, but not create an overstock of materials. This can be costly because of the extra storage space needed and possible deterioration of some types of materials. If materials are not kept on hand, bottlenecks or stalls may result during production. A bottleneck or stall is caused when production is stopped due to a shortage of materials. This is a temporary condition, but still results in "down time" and loss of output. A permanent bottleneck would be caused by the lack of proper facilities or equipment to keep materials moving at a constant rate. To help eliminate bottlenecks and stalls due to inventory shortages or poor record keeping, three types of production planning inventory systems might be incorporated. These inventory systems are as follows:

1. **Material Requirements Planning (MRP)**
2. **Optimized Production Technology (OPT)**
3. **Just-In-Time (JIT)**

Material requirements planning (MRP) was perfected in the United States in the 1970s. This system was devised for dependent-demand items, which are those materials that are to go into or become a part of another item. This technique uses back scheduling, which means subtracting from the due date to find the time at which a required item should be started into production or ordered from a supplier. The bill of materials is broken down to determine the **gross requirements**, or how many of each item are needed to produce the total number of finished products. Next, the stock balance on hand is subtracted from the gross requirements to determine the **net requirement**. With some additional calculations, order placement times can be determined so that materials are on hand when needed. Obviously, the computer made the applications of MRP much more efficient for company use. The second system used to help reduce bottlenecks is known as **optimized production technology (OPT)**. OPT uses two operating concepts. One is to move partially completed batches of work on to the next work center instead of waiting until the entire batch is completed. This reduces waiting time for the next work center and allows jobs to be started into production sooner. The second concept is to increase the size of the batches of work in process or run more of a high priority part once it has been set up on a particular machine. This cuts down on the amount of setup and changeover time at a given work center. The third system used to help reduce bottlenecks is called **just-in-time (JIT)**. This concept got its start about the same time that OPT was introduced into industry. The main purpose of JIT, as in MRP and OPT, is to reduce delays and get the work through the manufacturing processes quickly. This is accomplished by reducing lead time and decreases the need for a large amount of materials on hand. There may only be several days planned from the time the raw materials or parts arrive until they are placed into production, thus reducing large inventory costs. JIT gives more flexibility in the use of machines and personnel which makes capacity planning easier. One obvious disadvantage is that if a supplier delays delivery of an item, the manufacturing process may come to a halt due to lack of materials. Any one or all of these systems may be used in a company operation. Some companies may use MRP and OPT as subroutines of a JIT system.

It is evident that inventory control can be a very complicated process and care must be taken to insure its effectiveness. Since inventory activities supply the raw materials and parts for production, they must be continually monitored to maintain a continuous manufacturing process.

Student Activity Sheet: PPC.003

Students will discuss the advantages and disadvantages of the three main types of inventory control systems. They will also discuss how these affect the different types of inventories which must be maintained by a company.

The students will form panels of 5 to 6 members. Each panel will be given a product or a product drawing of a part to be manufactured. The panel will determine which inventory control system or combination of systems would be best used for the product. Each panel will defend its decision and explain the criteria used for its choice. The instructor will guide the discussions of the panels and act as mediator during the discussions.

Alternative Strategy for Activity Number: PPC.003

Have students form teams of 3 to 5 members. They will then select a product and analyze its components. Each group will make a list of the parts and materials needed to completely manufacture the product. The teams will then categorize these parts and materials into the following inventories and explain the importance of these inventories in the manufacture of the product.

1. Raw materials.
2. Purchased parts.
3. Work-in-process.
4. Finished parts.
5. Supplies.

The teams will defend their decisions and explain the criteria they used. The instructor will act as the leader and mediator for the teams.

Learning Check: PPC.003

Match the following:

___1. Raw materials

___2. Inventory

___3. MRP

___4. Finished products

___5. Inventory control

___6. Work-in-process

___7. OPT

___8. Supplies

___9. Purchased parts

__10. JIT

A. Procedures necessary to keep track of all the materials used in production.
B. Process where partially completed batches are moved to the next work center to reduce waiting time.
C. All the materials that need to be processed during manufacture.
D. Reduce lead time and material storage by having materials arrive when they are needed for production.
E. Listing of the amounts of all the materials and supplies owned by a company.
F. Ready-made parts and accessories used in production that will become a part of the finished product.
G. Materials used in the manufacture of a product, but are not major components.
H. Effective for dependent-demand items; uses back scheduling to determine inventory needs.
I. Products being built, but not yet finished.
J. Products that have completed the manufacturing process.

Record keeping is an important function of the inventory process. Companies must know at all times what materials are on hand and how many finished products are available for their customers. This also gives adequate time to order additional materials so that they will be available for production when needed. On the other hand, care must be taken not to overstock materials. This can be very costly in the manufacturing process. The ordering, storage, and retrieval of materials in inventory are very critical to the manufacturing system. When materials are needed, they are ordered using a **material requisition** form. The material requisition identifies the type and amount of materials needed, and gives all of the necessary specifications for the materials. The unit cost and total cost would also be listed in the material requisition. The material requisition would also include a **purchase order (P.O.)** number which identifies the order for future reference.

This process may also be done automatically when the inventory level is reduced to a certain point as in the **just-in-time (JIT)** system. This system reduces lead time in manufacturing and decreases the need to keep large amounts of materials on hand. The JIT system may only allow several days from the time the raw materials or parts arrive until they are placed into production, which reduces the amount of inventory on hand. The JIT timing technique is known as **Kanban,** which is a **pull** type system. This exists when the user signals or "pulls" more materials from the supplier. Kanban devices must communicate the need for more materials simply and accurately. Kanban places exact limits on the number or pieces of inventory between the maker and the user and sets forth exact locations for them. The quantities handled are usually small, but are in continuous flow. The **material requirements planning (MRP)** would be the opposite of Kanban. The MRP is a "push" type system where material orders are planned in advance, which when executed, cause work centers to make and push products forward.

Another method for restocking materials is known as **reorder point (ROP).** This is one of the oldest of the inventory timing approaches. In the **perpetual** system, stock is replenished when it drops to a reorder quantity. This level may be signaled in a number of ways: a two-bin system indicates a reorder when one bin is empty, a level marker might indicate that resupply is necessary or a divider in the supply container may show the point of reorder. In the **periodic** system, reorders are initiated at fixed intervals rather than when stock gets low.

If reorder is not closely maintained, two problems may occur. There may be a shortage of materials on hand, which will cause production to come to a halt, or an overstock may be created. This can become a costly inventory problem. Some companies like to maintain a **buffer stock**, or safety margin of materials on hand to insure that production supply does not fall short. An excessive buffer stock, however, is wasteful and can increase inventory costs.

Learning Check Answer Key: PPC.003

1. C

2. E

3. H

4. J

5. A

6. I

7. B

8. G

9. F

10. D

Performance Check: PPC.003

The instructor will observe the panel discussions and evaluate each student's input. The instructor will also consider the validity of the decisions of each panel. Written tests will be evaluated for each student.

ACTIVITY NUMBER PPC.004

BILL OF MATERIALS AND REQUISITIONS

Description:

A number of different types of materials may be needed to manufacture a given product. The manufacturer must determine what kinds of materials will be needed and how many to order at one time. This exercise will give you some experience in analyzing the components of a product and developing a material list. Students will be divided into teams of 2 to 3 students. Each team will develop a bill of materials for a product and complete a requisition for the materials.

Rationale:

It is important to have an understanding of the concept of a material inventory. Materials to be used for a product must be correctly determined and sufficient stock must be kept on hand to maintain a continuous flow of production.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of maintaining an inventory.
2. Identify and discuss inventory terminology such as ROP, Kanban, JIT, and Buffer stock.
3. Analyze a product or drawing to determine the materials needed for production of the product.
4. Complete a bill of materials for a product.
5. Complete a material requisition.

Tools, Materials, Machines and Resources:

1. Fales, James, Mervich, G., Sheets, E., & Dinan, J. (1986). Manufacturing. Mission Hills, CA: Glencoe Publishing Company.
2. Schonberger and Knod. (1988). Operations management. San Diego: Business Publications, Inc.
3. Wright, R. Thomas. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company.
4. Bill of Materials forms and Material Requisition forms (included for this unit).
5. Product and/or drawing to be analyzed.

Instructional Strategies:

The students will learn about maintaining an inventory through lectures and reading assignments. They will then work in teams to analyze a product and its components and develop a bill of materials for the product. The students will then complete a requisition for the materials needed to manufacture the product.

Safe Practices:

Careful handling and/or disassembly of products which are being analyzed.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Record keeping is an important function of the inventory process. Companies must know at all times what materials are on hand and how many finished products are available for their customers. This also gives adequate time to order additional materials so that they will be available for production when needed. On the other hand, care must be taken not to overstock materials. This can be very costly in the manufacturing process. The ordering, storage, and retrieval of materials in inventory are very critical to the manufacturing system. When materials are needed, they are ordered using a **material requisition form**. The material requisition identifies the type and amount of materials needed, and gives all of the necessary specifications for the materials. The unit cost and total cost would also be listed in the material requisition. The material requisition would also include a **purchase order (P.O.)** number which identifies the order for future reference.

This process may also be done automatically when the inventory level is reduced to a certain point as in the **just-in-time (JIT)** system. This system reduces lead time in manufacturing and decreases the need to keep large amounts of materials on hand. The JIT system may only allow several days from the time the raw materials or parts arrive until they are placed into production, which reduces the amount of inventory on hand. The JIT timing technique is known as **Kanban**, which is a pull type system. This exists when the user signals or "pulls" more materials from the supplier. Kanban devices must communicate the need for more materials simply and accurately. Kanban places exact limits on the number or pieces of inventory between the maker and the user and sets forth exact locations for them. The quantities handled are usually small, but are in continuous flow. The **material requirements planning (MRP)** would be the opposite of Kanban. The MRP is a "push" type system where material orders are planned in advance, which when executed, cause work centers to make and push products forward.

Another method for restocking materials is known as **reorder point (ROP)**. This is one of the oldest of the inventory timing approaches. In the **perpetual system**, stock is replenished when it drops to a reorder quantity. This level may be signaled in a number of ways: a two-bin system indicates a reorder when one bin is empty, a level marker might indicate that resupply is necessary or a divider in the supply container may show the point of reorder. In the **periodic system**, reorders are initiated at fixed intervals rather than when stock gets low.

If reorder is not closely maintained, two problems may occur. There may be a shortage of materials on hand, which will cause production to come to a halt, or an overstock may be created. This can become a costly inventory problem. Some companies like to maintain a **buffer stock**, or safety margin of materials on hand to insure that production supply does not fall short. An excessive buffer stock, however, is wasteful and can increase inventory costs.

Before any materials can be accurately ordered for processing into a product, the manufacturer must determine exactly what is needed. A **bill of materials (BOM)** is developed to describe what it is that will be needed to produce the product. The bill of materials is a list of the component parts that go into a product. The BOM identifies each of the parts detailed on the engineer's blueprints and gives detailed information regarding the number of parts, size of each piece, and the type of material to be used. The cost of the materials may also be listed on the BOM.

Another type of bill of materials is known as the **multi-level BOM** where parts go into sub-assemblies and the subassemblies fit into devices. Complex devices may have three or four levels. Common parts may be another consideration in a bill of materials. This is where the same part is used in more than one device. This further complicates the inventory control function as well.

The importance of maintaining an inventory is apparent to the operation of a manufacturing process. The materials must be on hand to provide a continuous flow for producing finished products, but not be in such an oversupply that would cause costly storage problems.

Student Activity Sheet Number: PPC.004

Divide students into teams of 2 to 3 members. Each team will be given a product or product drawing to analyze. Students may use the product which was developed in the product design Activity .001 or use one which will be supplied by the instructor. Using the product or drawing, each will develop a bill of materials (BOM). Use the Bill of Materials form included in this unit (see PPC.004/Fig. 6).

After carefully analyzing the product, each team will complete the following:

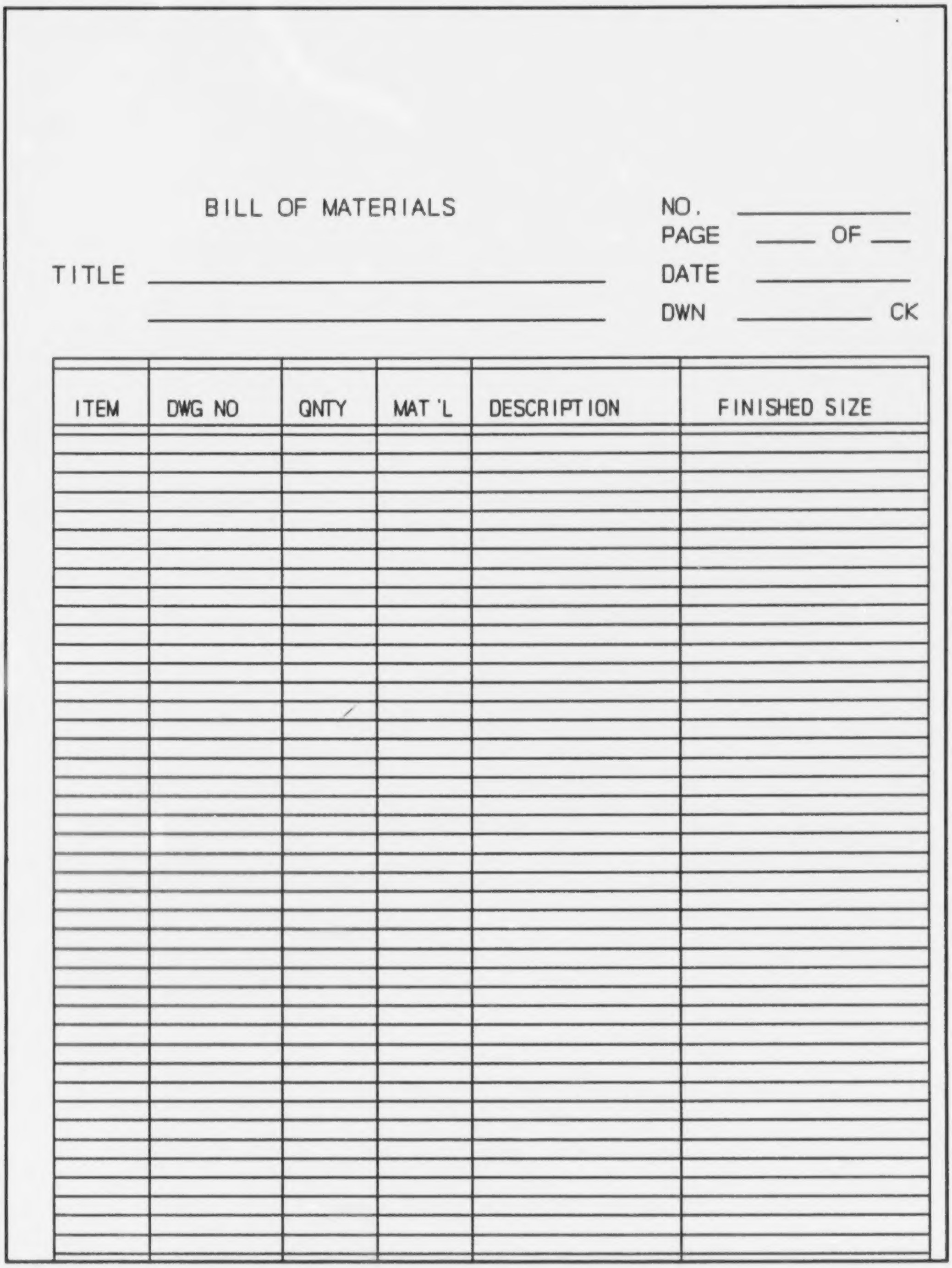
1. List the name of each of the parts required for the product.
2. List the quantity of each part.
3. Describe the type of material to be used.
4. Show the size of stock needed to produce each part.
5. List the cost of the material for each piece.

After the BOM has been completed and checked by the instructor, each team will complete a material requisition form (see PPC.004/Fig. 7). This form will be completed using the bill of materials as a reference for the type of materials to be ordered. Each team should order enough materials to manufacture 50 products. Remember to allow for some waste or defective parts during processing. These amounts should be decided upon by the teams.

The material requisition should include the following information:

1. Name of the supplier.
2. Date, order number and type of shipment.
3. Specifications of materials from BOM.
4. Cost of materials.

After both forms have been completed, the instructor will conduct a group discussion on the accuracy of the forms and compare the results among the teams. Each team should be prepared to explain the content of their forms.

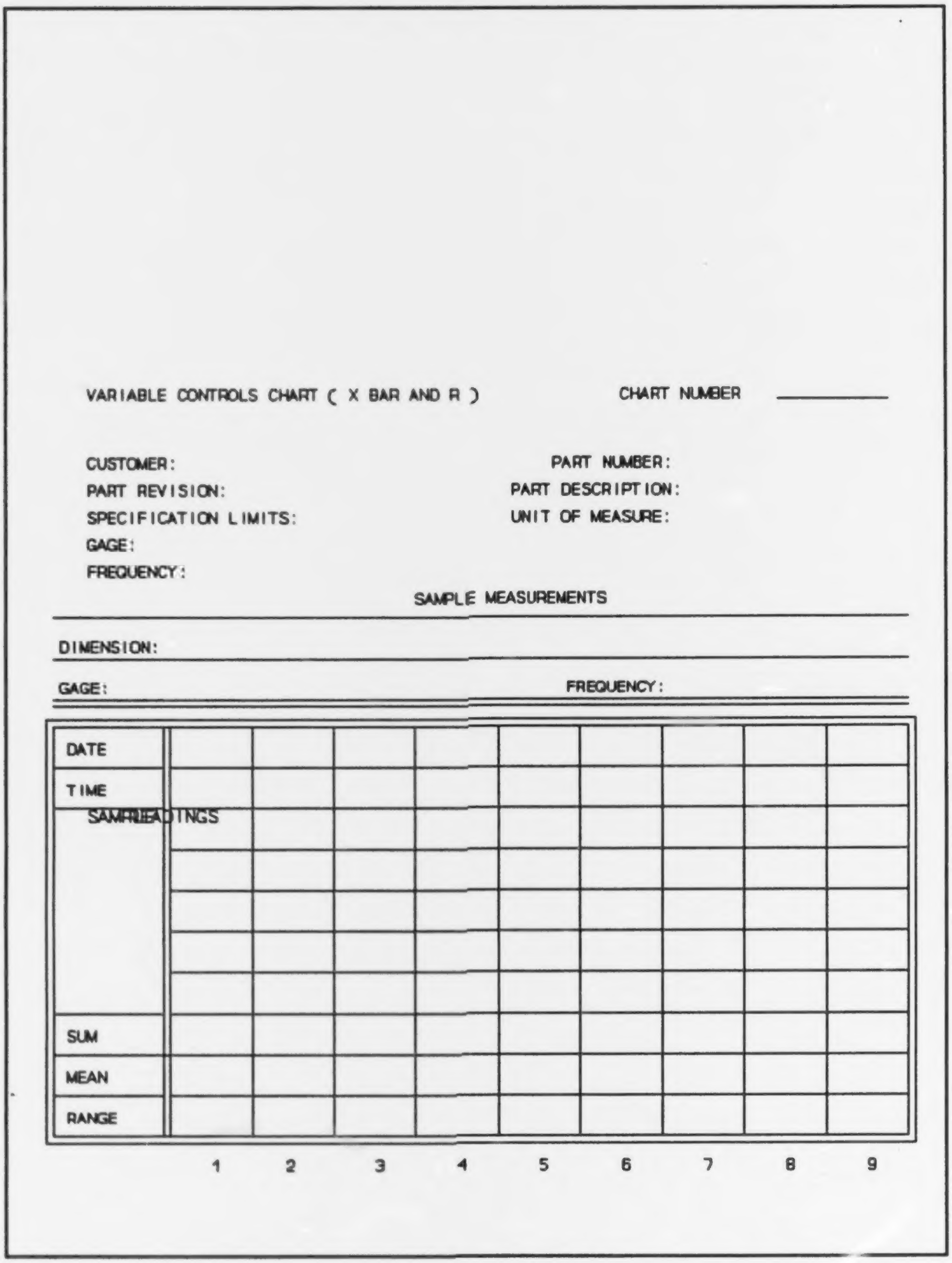


BILL OF MATERIALS

NO. ____________
PAGE ____ OF ____
TITLE ______________________________
____
DATE ____________
DWN ____________ CK

ITEM	DWG NO	QNTY	MAT 'L	DESCRIPTION	FINISHED SIZE

PPC.004/Fig. 6. Bill of Materials
(PRODUCT AND PROCESS CONTROL, PPC.004)



VARIABLE CONTROLS CHART (X BAR AND R) CHART NUMBER ________

CUSTOMER:
PART REVISION:
SPECIFICATION LIMITS:
GAGE:
FREQUENCY:

PART NUMBER:
PART DESCRIPTION:
UNIT OF MEASURE:

SAMPLE MEASUREMENTS

DIMENSION:

GAGE: FREQUENCY:

DATE									
TIME									
SAMPLE READINGS									
SUM									
MEAN									
RANGE									
	1	2	3	4	5	6	7	8	9

PPC.004/Fig. 7. Material Requisition
(PRODUCT AND PROCESS CONTROL, PPC.004)

Alternative Strategy for Activity Number: PPC.004

The students would be asked to bring in samples of bills of material and requisition forms from other sources, such as other lab classes, companies in the community, or the library. A group discussion could be conducted by comparing and contrasting the different forms and the various specifications used to identify different types of products.

Learning Check Sheet: PPC.004

Match the following:

___1.	P.O.	A.	A method for restocking materials needed for production.
___2.	Buffer Stock	B.	A number which identifies a material requisition for future reference.
___3.	BOM	C.	Stock inventory is replenished when levels reach a predetermined point.
___4.	Periodic	D.	An extra safety margin of stock inventory.
___5.	Kanban	E.	Stock inventory is replenished at fixed intervals.
___6.	Perpetual	F.	A detailed description of what is needed to produce a product.
___7.	Requisition	G.	A "pull" type inventory timing system such as JIT, in which the manufacturer requests materials.
___8.	ROP	H.	Identifies the type and amount of materials to be ordered.
___9.	MRP	I.	A "push" type inventory timing system in which material orders are planned in advance.

Discuss the following:

1. Explain the importance of maintaining an inventory.

2. Explain why care must be taken when completing a bill of materials and material requisition form.

Learning Check Sheet Answer Key: PPC.004

1. B
2. D
3. F
4. E
5. G
6. C
7. H
8. A
9. I

Performance Check: PPC.004

The instructor will evaluate the bills of materials and material requisition forms to assess the level of accuracy to which they were completed. The students will also be evaluated on their test performance.

ACTIVITY NUMBER PPC.005

TRANSFER OF INVENTORY MATERIALS

Description:

The processing of materials in manufacturing is not simply a task of placing raw materials from receiving directly into production. We must have a set of inventory control procedures for incoming materials before they are processed. We must also have a method for moving these materials through the production process. This exercise will give you an understanding of vendor material control and transfer of inventory material to the production area. Students will be introduced to some of the procedures and processing forms used in this area of inventory control. The students will form teams and evaluate the school shop facility and make recommendations for methods of inventory control.

Rationale:

Vender material control is an important concept in the inventory process. Materials must be inspected before they are transferred to production to minimize defective parts due to bad materials. The transfer of materials from the correct storage area to production is also critical to the manufacturing process.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of vendor material control.
2. Discuss material storage techniques.
3. Discuss some of the methods used to transfer materials to production.
4. Identify some of the forms used for vendor material control, such as the incoming audit plan, non-conforming material notice, delivery receipt, and lot traceability tag.
5. Analyze a shop facility and make recommendations for inventory control procedures.

Tools, Materials, Machines and Resources:

1. Buhrke, P. (1988). Quality control manual. Arlington Heights, IL: Buhrke Industries, Inc.
2. Schonberger and Knod. (1988). Operations management. San Diego: Business Publications, Inc.
3. Wright, R. T. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company.
4. Samples of forms used for vendor material control (included for this unit).

Instructional Strategies:

The instructor will lecture on the importance of vendor material control and present examples of nonconforming materials. The procedures and processing forms used in this area will be discussed. Group interaction will be used to examine material transfer methods and the importance of storage control.

Safe Practices:

No safety practices will be necessary in this unit.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

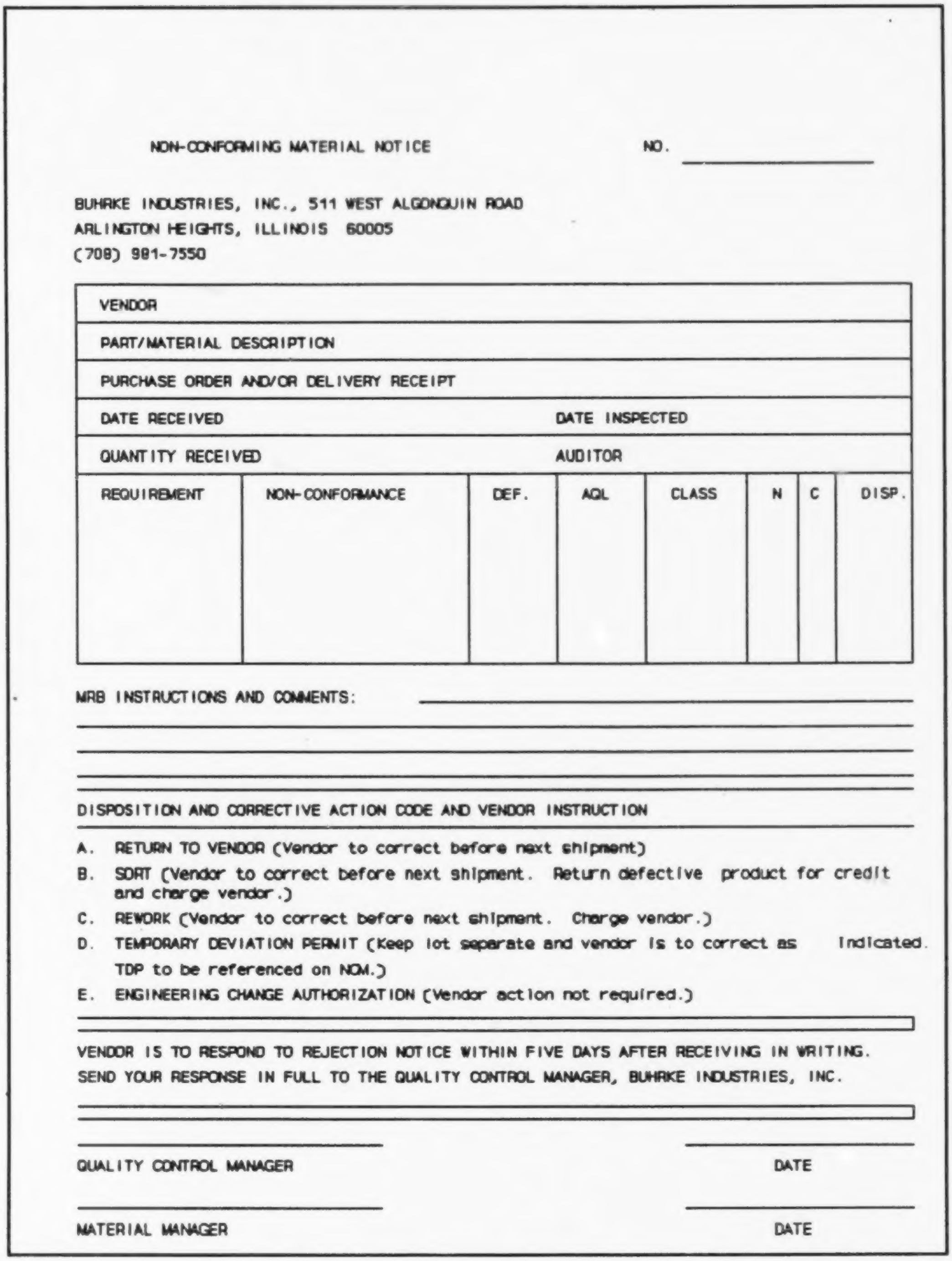
Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

The receiving, storage, and retrieval of materials in inventory is very critical to the manufacturing system. When a shipment of raw materials is received, the materials are inspected to insure that they meet the quality standards needed for production. If defective materials are found, a **nonconforming material** notice may be issued **(see PPC.005/Fig. 8)**. This form shows the type of material, the amount received, the date received and the date of the inspection. The nonconforming material notice also lists the production requirements for the material and gives a description of the nonconformance. The materials would then be secured in a nonconforming material storage area. The disposition of the material must be determined by the buyer and corrective action taken. Several actions may be taken. The material may be returned to the vendor; sorted, reworked by the vendor; or a change may be authorized in the engineering plan. The vendor would then be notified to determine what is to be done with the defective materials. The just-in-time (JIT) inventory system has decreased the need for incoming inspection. This is accomplished through the certification of suppliers.

This information would be recorded in an **incoming audit plan (see PPC.005/Fig. 9 and 9A)**, which includes such things as date received, number of parts, quality standards, inspection date and purchase order (P.O.) number. The raw materials and parts must then be transferred to production. This may be done on a **first in first out (FIFO)** basis, in which the oldest material in the inventory is removed first and only new incoming materials are left in storage. There is a continuous turnover of all materials in the inventory when this type of system is used. The other system which may be used is **last in first out (LIFO)**, in which the last materials to be received are the first to go into production. This system would involve less handling of materials in storage; however, some of these materials may be in storage for long periods of time. LIFO would not be used when dealing with perishable materials.

All materials leaving the storage for production must be identified. This is done by lots, or units of materials which are transferred to the production area at one time. A **lot traceability tag** is transferred with each unit, identifying the materials. This tag will follow the lot through production and be used to record operations completed, dates, employee numbers, and any additional information which may be noted about the lot of materials. This type of control system makes it much easier to trace specific problems or defects during production, rather that checking all parts or all processing stations. The materials are then ready to be transferred to the production area.



NON-CONFORMING MATERIAL NOTICE NO. ______________

BUHRKE INDUSTRIES, INC., 511 WEST ALGONQUIN ROAD
ARLINGTON HEIGHTS, ILLINOIS 60005
(708) 981-7550

VENDOR	
PART/MATERIAL DESCRIPTION	
PURCHASE ORDER AND/OR DELIVERY RECEIPT	
DATE RECEIVED	DATE INSPECTED
QUANTITY RECEIVED	AUDITOR

REQUIREMENT	NON-CONFORMANCE	DEF.	AQL	CLASS	N	C	DISP.

MRB INSTRUCTIONS AND COMMENTS: ______________

DISPOSITION AND CORRECTIVE ACTION CODE AND VENDOR INSTRUCTION

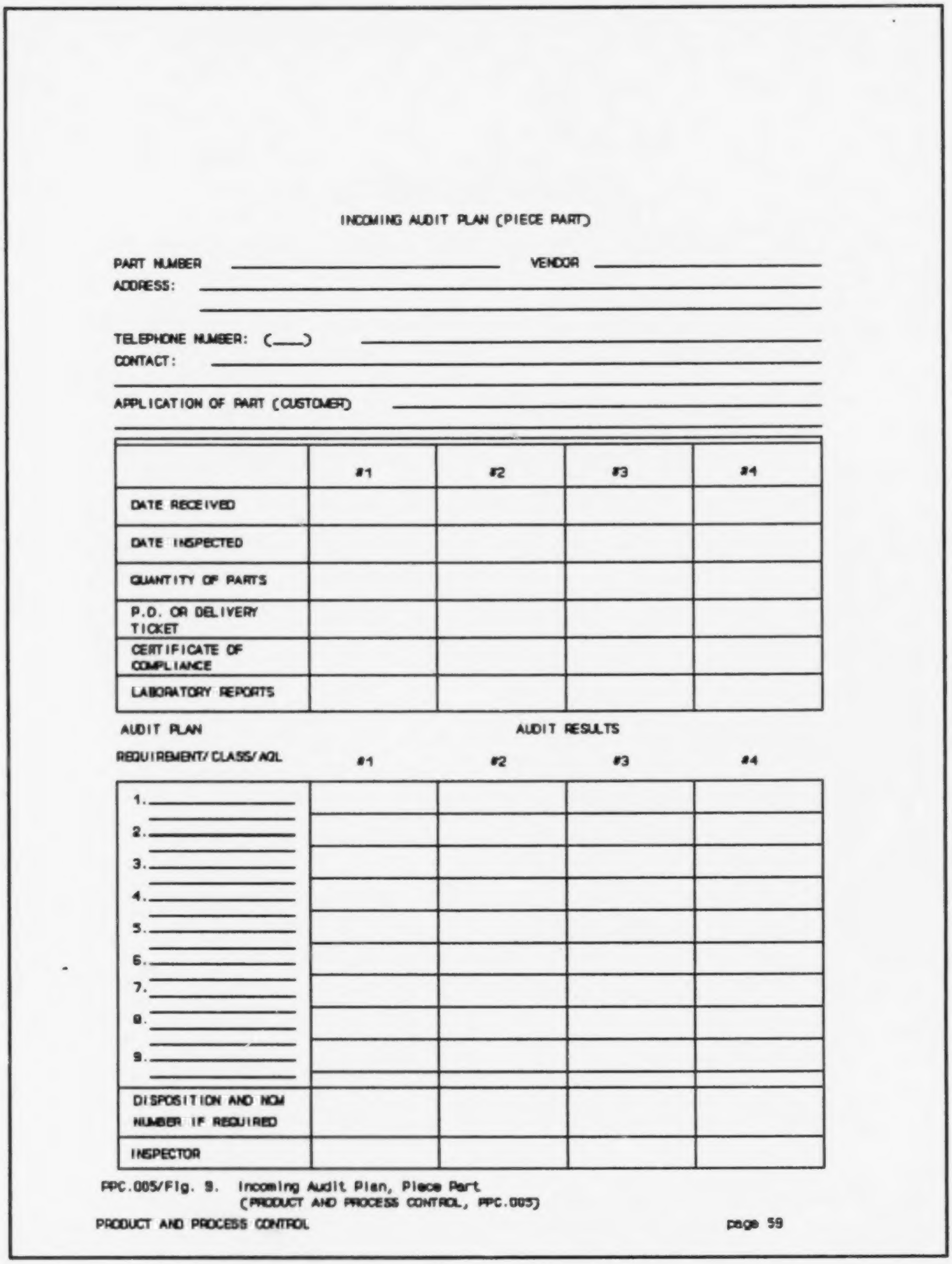
A. RETURN TO VENDOR (Vendor to correct before next shipment)
B. SORT (Vendor to correct before next shipment. Return defective product for credit and charge vendor.)
C. REWORK (Vendor to correct before next shipment. Charge vendor.)
D. TEMPORARY DEVIATION PERMIT (Keep lot separate and vendor is to correct as indicated. TDP to be referenced on NCM.)
E. ENGINEERING CHANGE AUTHORIZATION (Vendor action not required.)

VENDOR IS TO RESPOND TO REJECTION NOTICE WITHIN FIVE DAYS AFTER RECEIVING IN WRITING.
SEND YOUR RESPONSE IN FULL TO THE QUALITY CONTROL MANAGER, BUHRKE INDUSTRIES, INC.

QUALITY CONTROL MANAGER ______________ DATE ______________

MATERIAL MANAGER ______________ DATE ______________

PPC.005/Fig. 8. Non-Conforming Material Notice (PRODUCT AND PROCESS CONTROL, PPC.005)



INCOMING AUDIT PLAN (PIECE PART)

PART NUMBER ______________________ VENDOR ______________________
ADDRESS: ______________________
____
TELEPHONE NUMBER: (___) ______________________
CONTACT: ______________________
____
APPLICATION OF PART (CUSTOMER) ______________________
____

	#1	#2	#3	#4
DATE RECEIVED				
DATE INSPECTED				
QUANTITY OF PARTS				
P.O. OR DELIVERY TICKET				
CERTIFICATE OF COMPLIANCE				
LABORATORY REPORTS				

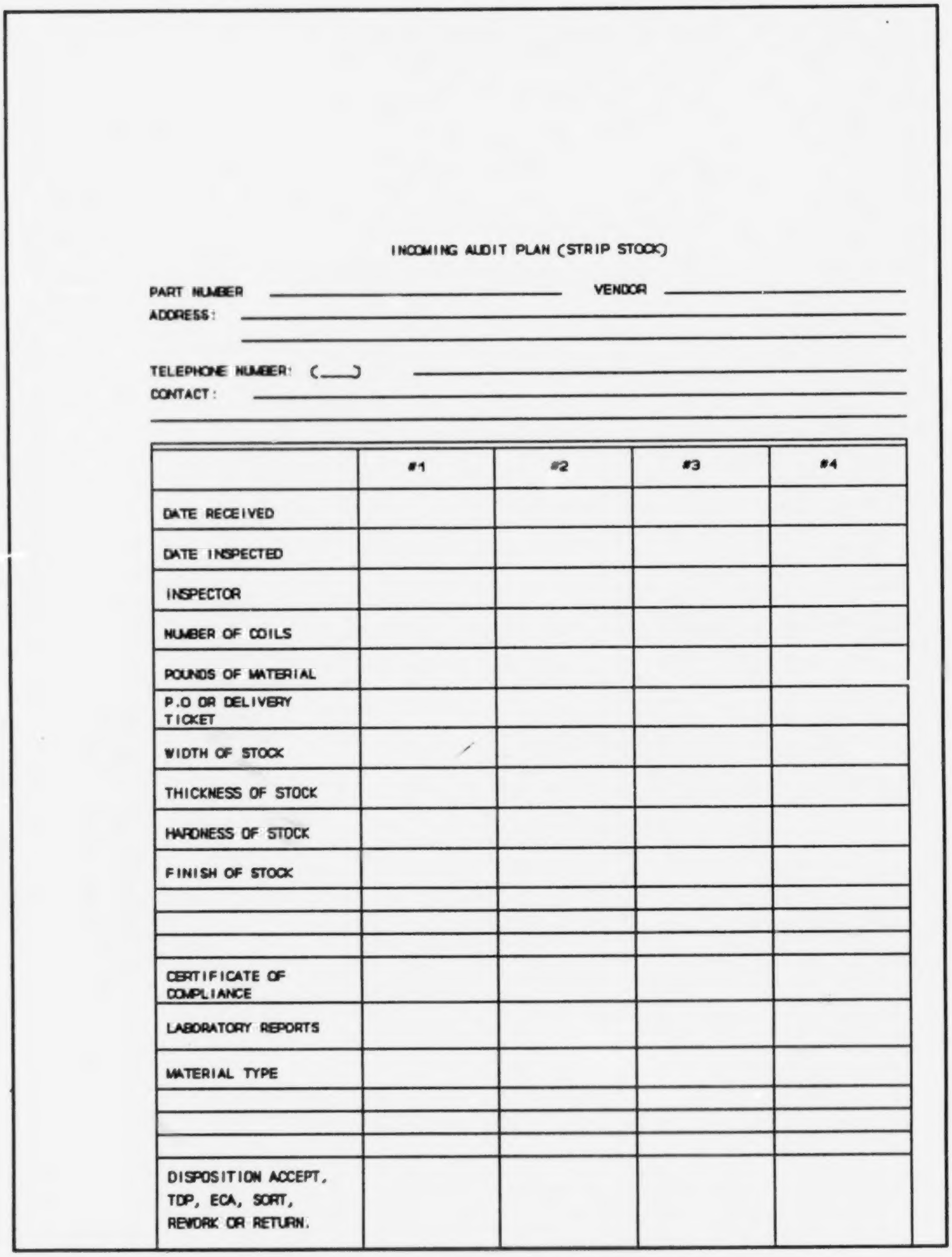
AUDIT PLAN — AUDIT RESULTS

REQUIREMENT/CLASS/AQL	#1	#2	#3	#4
1. ______				
2. ______				
3. ______				
4. ______				
5. ______				
6. ______				
7. ______				
8. ______				
9. ______				
DISPOSITION AND NCM NUMBER IF REQUIRED				
INSPECTOR				

PPC.005/Fig. 9. Incoming Audit Plan, Piece Part
(PRODUCT AND PROCESS CONTROL, PPC.005)

PRODUCT AND PROCESS CONTROL page 59

PPC.005/Fig. 9. Incoming Audit Plan, Piece Part
(PROCESS AND PRODUCT CONTROL, PPC.005)



INCOMING AUDIT PLAN (STRIP STOCK)

PART NUMBER ______________________ VENDOR ________________

ADDRESS: ____

TELEPHONE NUMBER: (___) ________________________

CONTACT: ____

	#1	#2	#3	#4
DATE RECEIVED				
DATE INSPECTED				
INSPECTOR				
NUMBER OF COILS				
POUNDS OF MATERIAL				
P.O OR DELIVERY TICKET				
WIDTH OF STOCK				
THICKNESS OF STOCK				
HARDNESS OF STOCK				
FINISH OF STOCK				
CERTIFICATE OF COMPLIANCE				
LABORATORY REPORTS				
MATERIAL TYPE				
DISPOSITION ACCEPT, TDP, ECA, SORT, REWORK OR RETURN.				

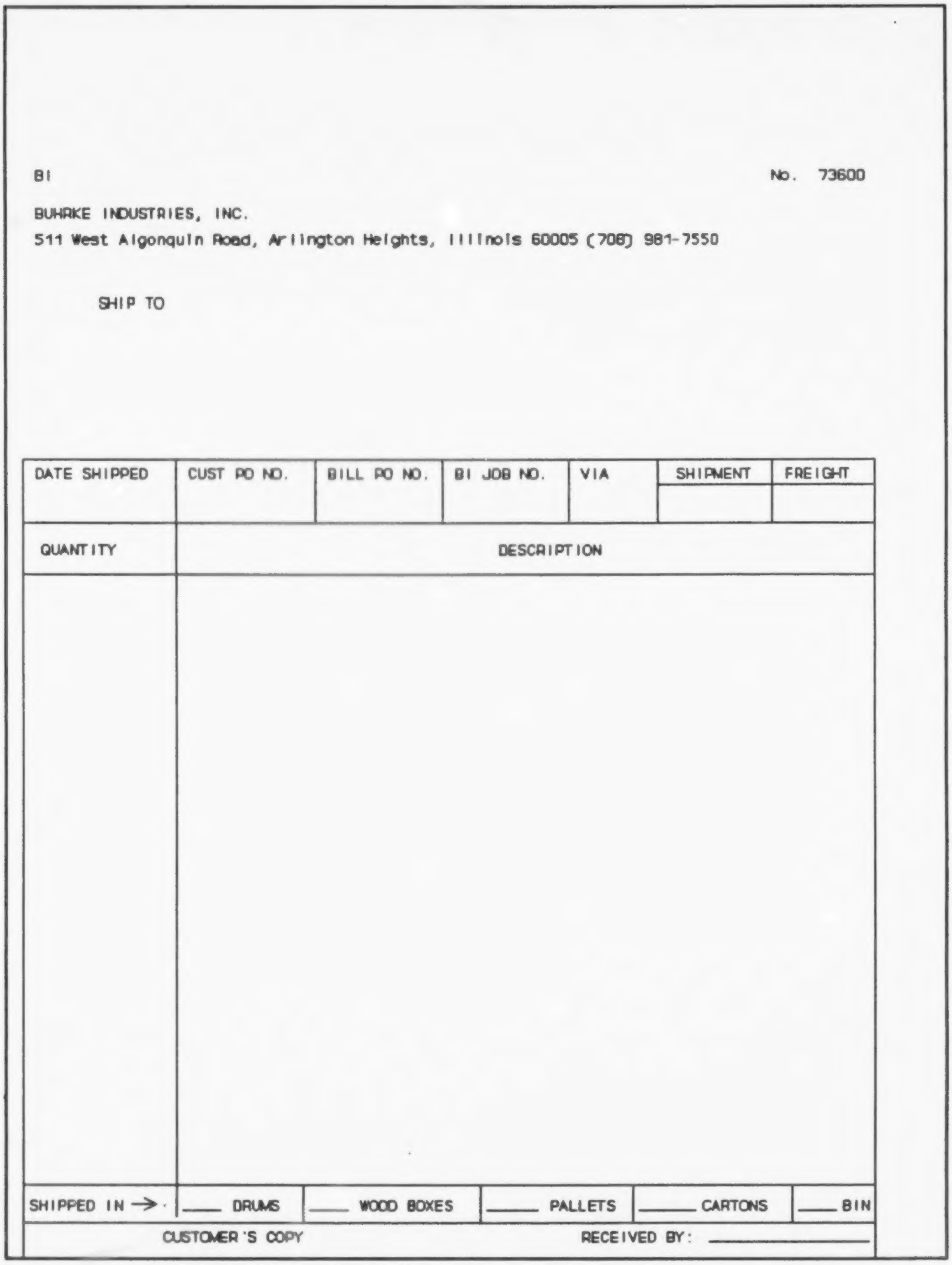
PPC.005/Fig. 9A. Incoming Audit Plan, Strip Stock
(PRODUCT AND PROCESS CONTROL, PPC.005)

The materials may be transferred to the production area manually, or a computerized system may be used. Manual transfer of materials may include the use of a forklift, a gravity type conveyor system, mechanized conveyors, or personnel carrying the materials to the production area. A computerized system may be faster and more efficient for production, however, it would also be more costly to put into operation. One such system is known as an **automated storage and retrieval system (ASRS)**, in which the materials are stored and identified with a computerized system. The materials are identified by the computer and removed from storage by an automated vehicle. From the storage area, the materials may then be moved around the factory by means of an **automatic guided vehicle system (AGVS)**. These systems use programmable robotic equipment for moving the materials and parts. This type of system provides for very close control of inventory and parts in process, since all of the inventory information is stored in the computer and is continuously updated. Reorder of materials and movement of materials into production can be done automatically.

Finished products must be shipped or stored after the production process has been completed. These must also have a final inspection before they are shipped or stored. If they are stored, they must be placed in a finished goods inventory, so that they can be properly identified when they are needed. If finished products are delivered to the customer, a **delivery receipt (see PPC.005/Fig. 10)** is filled out to identify the goods delivered and to insure that delivery was made.

We must remember that in a total JIT operation, many of the above-mentioned operations are eliminated, thus saving considerable indirect costs. The vendor's material is delivered on a fixed schedule and is usually not counted or inspected. It is also delivered directly to the line, bypassing the stocking activities.

Inventory control is important in all phases of production. The incoming materials, work-in-process, and finished products must be accounted for to properly assess production levels and to have the capability to trace materials or products at any time.



BI

No. 73600

BUHRKE INDUSTRIES, INC.
511 West Algonquin Road, Arlington Heights, Illinois 60005 (708) 981-7550

SHIP TO

DATE SHIPPED	CUST PO NO.	BILL PO NO.	BI JOB NO.	VIA	SHIPMENT	FREIGHT

QUANTITY	DESCRIPTION

SHIPPED IN → ____ DRUMS ____ WOOD BOXES ____ PALLETS ____ CARTONS ____ BIN

CUSTOMER'S COPY RECEIVED BY: ________________

PPC.005/Fig. 10. Delivery Receipt
(PRODUCT AND PROCESS CONTROL, PPC.005)

Student Activity Sheet: PPC.005

In this activity, students will be asked to evaluate the school shop facility to determine if there are possible controls for shop inventory. The students will be divided into 3 teams. One team will be assigned to the incoming materials area and storage room, another to the shop area and the third to finished project storage. Each team should analyze the area assigned and make recommendations for control procedures.

The following information should be analyzed:

Incoming Materials Area

1. Receiving and unloading area.
2. Equipment and procedures for unloading.
3. Incoming stock checklist and identification.
4. Transfer of stock to storage area.
5. Material storage--storage racks, identification, and accessibility.
6. Stock turnover (LIFO, FIFO).
7. Identification and recording of stock transferred to shop work in process.

Shop Work-In-Process Area

1. Retrieval of material from storage area--identification, recording, etc.
2. Identification of material during processing.
3. Storage of work-in-process.

Finished Project Area

1. Transfer of project from work in process to storage area.
2. Identification of finished projects.
3. Material storage--storage racks and accessibility.
4. Preparation of materials for storage--protective coatings, wrapping, stacking, etc.
5. Storage security.
6. Removal of projects from storage--identification, transfer method, etc.

The teams will then present their ideas to the group for discussion and make recommendations for implementation.

Alternative Strategy for Activity Number: PPC.005

The students would be asked to evaluate the inventory control system used by a local company. This could be done individually or by assigning teams. The students could select and visit companies on their own or a field trip could be organized for this purpose. The instructor may want to check that a variety of types and sizes of companies are used. The teams would then submit a written evaluation to the instructor and report their findings to the group for discussion.

Lot Traceability

A system for positive identification and record keeping for each lot throughout production and inspection and testing must be consistent with the production facilities and operations.

- One lot code is assigned to a lot regardless of the number of shipping releases.
- When successive subdivisions of the lot are necessary, the principal code must be supplemented by additional subordinate codes to identify each of the sublots. Each container must be identified by the principal code and subordinate codes.
- Records indicating inspection or test results contain the principal and subordinate lot code.
- The final inspection reports are cross-referenced to supporting inspection and test documents and the Buhrke or supplier code.
- Shipping documents reference principal and subordinate lot codes.
- Shipping destinations for all parts must be determined for each lot.

Learning Check: PPC.005

Complete the following:

1. Defective materials received from suppliers are known as ________________________.

2. ________________________________ is a complete record of materials received from suppliers.

3. An inventory process in which the oldest materials in storage are transferred to production first is known as________________________.

4. Once in process, defects in materials might be traced to the source by referring to the ____________________________.

5. An inventory process in which the materials received are put into production first, while others are left in storage is known as ____________________________.

6. An identification slip for finished goods that have been shipped to a customer is called a ______________________.

Discuss the following:

1. Explain the importance of vendor material control.

2. Explain the difference between ASRS and AGVS.

Learning Check Answer Key: PPC.005

1. Nonconforming material
2. Incoming audit plan
3. First in first out (FIFO)
4. Lot traceability tag
5. Last in first out (LIFO)
6. Delivery receipt

Performance Check: PPC.001

The instructor will evaluate the findings of the teams for the inventory control exercise. Each student will also be evaluated on his test performance.

ACTIVITY NUMBER PPC.006

PLANT LAYOUT DESIGN

Description:

Plant layout is a critical factor in the flow of materials in a manufacturing system. Economic use of space for manufacturing equipment and transfer systems is also important in producing a product. This activity will introduce the students to some of the factors which affect the layout of a manufacturing system. Students will be divided into groups of three or four and the group will determine the type of production to be used. The students will then develop a plant layout for producing a product.

Rationale:

The careful design and layout of a manufacturing system may greatly improve operational efficiency and increase productivity. Students will learn why engineers spend a great deal of time developing an efficient plant layout system for manufacturing a product.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of developing a plant layout system for manufacturing a product.
2. Name and explain the difference between the four types of plant layout designs.
3. Discuss five of the factors involved in determining plant layout.
4. Make a scale drawing of a shop floor plan and design a layout plan for producing a product.

Tools, Materials, Machines, and Resources:

1. Schonberg and Knod. (1988). Operations management. San Diego: Business Publications, Inc. (pp. 713-786)
2. Wright, R. T. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Co. (pp. 162-184)
3. Production technology (pamphlet). (1984). Macomb, IL: Western Illinois University, Department of Adult, Vocational, and Technical Education.
4. Technology education: Manufacturing technology (pamphlet). (1987). Grand Forks, ND: Department of Technology.
5. The challenge of manufacturing (video about various segments of manufacturing). St. Petersburg, FL: Modern Talking Picture Service.
6. Access to a shop facility for the student to draw a shop floor plan.
7. Plant layout grid and diagram of machine symbols (included in this unit).
8. Computer software programs for floor plan design.
9. Field trip to local manufacturing company.

Instructional Strategies:

The instructor will lecture about plant layout and discuss how it affects the manufacturing process. A video may be shown on a manufacturing system to show an actual production operation. The students will then be organized into teams to develop a plant layout. A field trip may be incorporated into the unit of study to introduce students to a manufacturing system in operation.

Safe Practices:

Follow general shop safety rules when using shop facility to draw the floor plan.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

___x___ Assertiveness
___x___ Negotiation
___x___ Listening
___x___ Risk Taking

Change:

___x___ Personal Adaption
______ Professional Adaption

Computer:

___x___ Operating Systems
___x___ Keyboards
___x___ Applications___Floor Plan Design_________

Decision Making:

______ Ethical Reasoning
___x___ Logical Reasoning
___x___ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
___x___ Implementation

Plant layout has become a very critical factor in the efficiency of the manufacturing system. Product and process control can be more easily maintained if careful planning has been done in the layout of the equipment and facilities of the plant.

There are several things which influence the development of the process plan for a particular plant layout:

1. The type of manufacturing system.
2. The kind of product to be manufactured.
3. The kinds of manufacturing equipment and tools to be used.
4. The location of the manufacturing equipment and accessories.
5. The types of transfer systems.

The **types of manufacturing system** would have a direct influence on the layout plan of the plant facilities. **Custom** manufacturing, such as tool and die, would be suited for a small number of parts having a higher degree of accuracy. The second type, known as **intermittent or job** manufacturing, might be more suitable for a product made in a variety of sizes and shapes. An example of this might be blow molding several different plastic bottles. The third type of manufacturing is **continuous or line.** This process would be ideal for making a large number of parts which have a less complex design, such as the stamping of parts or the manufacture of plywood. The type of manufacturing system would determine a large part of the layout plan. The **kind of product** to be manufactured would be critical to the arrangement of the machines and equipment in the facility. In an existing facility, the floor plan layout would need to be evaluated to determine if changes had to be made. We must also consider the sequence of operations required to finish the part and the number of stations needed for the entire process. The **kinds of equipment and tooling**, would be a third factor in the layout plan. The accuracy and complexity of the parts to be manufactured may require specialized machines and tools, or additional operations to be performed. Automated equipment may complete the job much more accurately and efficiently, but manual machines may be more cost effective for fewer parts of less complexity.

The **location of the equipment and accessories** would also influence the layout plan. Four types of layout may be considered by the process planner. The **process layout** is a method of arranging facilities into process groups to allow for easier maintenance, utility hookups, control of fumes, and removal of chips. However, the current trends in manufacturing are moving away from process layout and toward product or cellular layout. This is based on the philosophy to minimize work-in-process by using a continuous flow of products without batching. The second type of layout is known as **product layout.** This is the laying out of the facilities along product-flow lines in a production line setup. The **cellular layout** is the third type. This is where work stations are arranged into groups that process families of parts that follow similar flow paths. The last type is a **fixed layout.** In this type of layout, the product is fixed and the facilities move around it. An example of this would be in the aircraft industry, where the vehicles are too large to move through a plant facility.

The **type of transfer system** would determine how the product was moved through the plant. Once again, the plant may be equipped with a highly sophisticated computerized system or simply use mechanical means to move parts from station to station. In a computerized system, equipment would be very critical because of movement and reach limitations of robot arms and automated conveyor systems.

If large quantities of the same product were to be manufactured, then the **sequence of operations** would be a critical factor in the type of plant layout. Product and process control would be much easier to maintain if the plant layout was of the highest efficiency for the product being manufactured. The **number of stations** needed to process the product will also be a concern in the layout plan. There must be enough open space to allow for free movement of personnel, materials, and machines; yet the time and task of moving parts from one work to the next must be kept to a minimum.

Plant layout must be carefully evaluated to determine the most efficient process plan for the product being considered for manufacture. Effective product control would require accessibility to the product at various stages of completion for quality control applications. Effective process control would require accessibility to all the machines and accessories being used to process the parts. Open space would have to be available to move work in process from one area to the next. An efficient plant layout system will mean more efficient production in a manufacturing system.

Student Activity Sheet: PPC.006

Students will be given the task of designing a plant layout for manufacturing a product. The product designed in Activity .001 may be used for this exercise. The students will form teams of 3 to 5 members who will determine the most efficient layout plan for production. The students will be provided with plant layout templates (**see PPC.006/Fig. 11**) which can be arranged on the layout plan to symbolize location of facilities. Remember that the plant layout should allow parts and products to move through the plant and the production sequence as efficiently as possible. Your laboratory facility will be used for the layout plan.

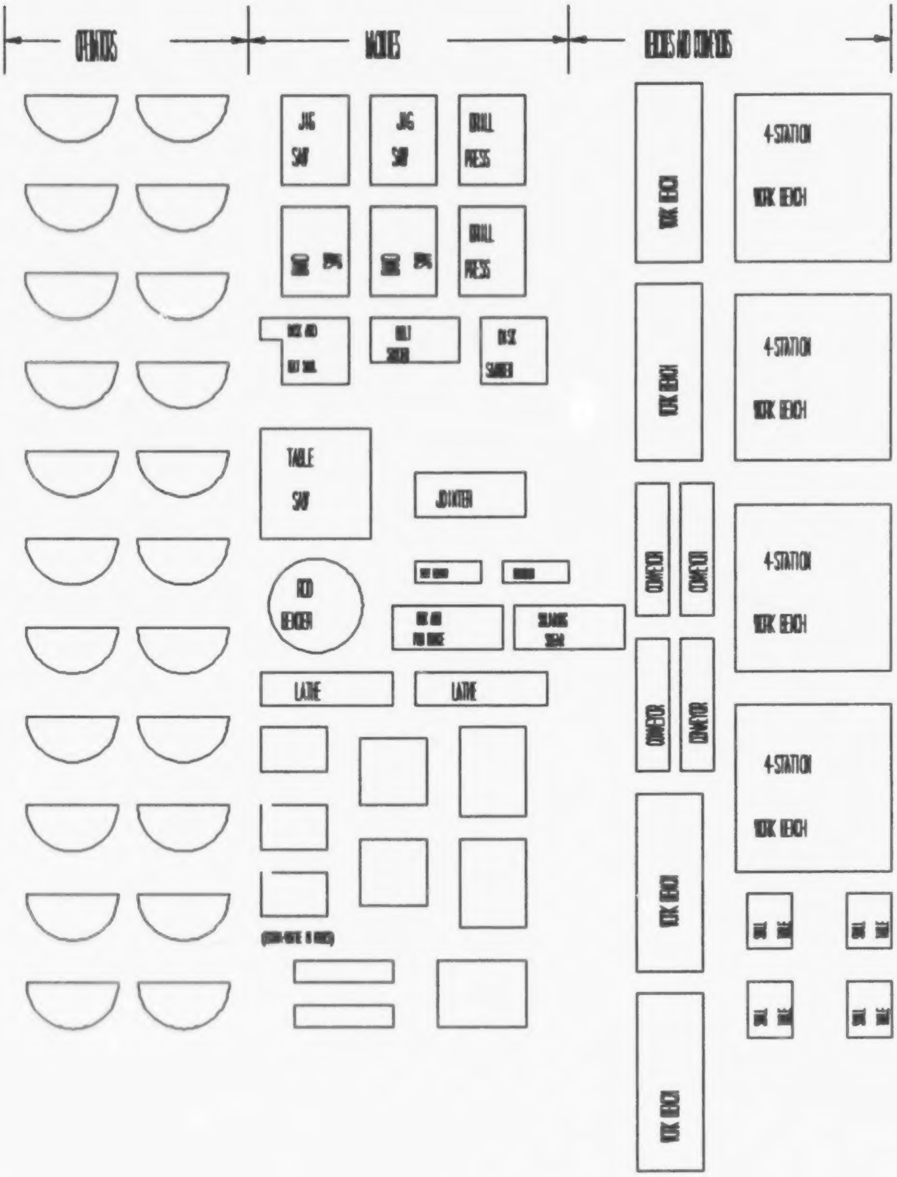
The plant layout should include the following:

1. Locations for personnel and machines.
2. Paths for material transportation during production.
3. Sequence of operations for producing the product.
4. Safe and efficient production plan.
5. Minimal movement of personnel and materials.
6. Locations of plant outlets for incoming and outgoing materials.

The following plant layout procedures will be used:

1. Draw a basic floor plan of your lab facility on your plant layout sheet (**see PPC.006/Fig. 12**). Be sure to include and identify the walls, entrances, storage areas, and any accessories that might be needed to operate equipment.
2. Cut out the templates for the machines, benches, conveyors and other equipment in your lab. Cut out an operator's template for each member of your class.
3. Position your templates on the plant layout sheet for those machines and equipment that can not be moved easily.
4. Lay out the remaining templates using a process plan as a guide. The process plan developed in PPC.002 may be used as a reference. Experiment with the locations of machines, conveyors, and equipment to determine the best sequence of operations.

PLANT LAYOUT TEMPLATES


OPERATORS
MACHINES
BENCHES AND CONVEYORS
JIG SAW
JIG SAW
DRILL PRESS
DRILL PRESS
DISK SANDER
TABLE SAW
JOINTER
ROD BENDER
LATHE
LATHE
WORK BENCH
4-STATION WORK BENCH
WORK BENCH
4-STATION WORK BENCH
CONVEYOR
CONVEYOR
4-STATION WORK BENCH
CONVEYOR
CONVEYOR
4-STATION WORK BENCH
WORK BENCH
WORK BENCH

PPC.006/Fig. 11. Plant Layout Templates
(PRODUCT AND PROCESS CONTROL, PPC.006)

PLANT LAYOUT

PRODUCT NAME:

PREPARED BY:

PPC.006/Fig. 12. Plant Layout
(PRODUCT AND PROCESS CONTROL, PPC.006)

5. After determining the best layout, secure the templates to the layout sheet. Now place the operators on the sheet, making sure they are clear of danger zones.

6. Present your plant layout proposal to the other teams. Be prepared to explain your layout design. The group may then select the most efficient plant layout plan, or, if necessary, design a new one using the suggestions of the group.

Alternative Strategy for Activity Number: PPC.006

Activity #1

Divide the students into teams of 3 to 5 members. Each team will visit and evaluate another lab facility. A field trip could be organized or students could locate local companies in the community and set up a tour. Another lab facility in the school could also be used. Each team will evaluate the facility for efficiency of operation. The students will first write a description of the activities in the lab or the type of product being manufactured. They will sketch the facility layout. Each team will then make recommendations regarding the efficiency of the existing operation and suggest improvements in the layout plan.

Activity #2

The students will complete a research exercise in the library. They will research the four different types of plant layouts and discuss the advantages and disadvantages of each design. The students will also discuss the various types of products that each plant layout would be suitable to manufacture. They would include such things as type of products, machines and accessories, transfer systems and personnel.

Activity #3

The students will construct a table-top model of the shop layout necessary to complete a product. This model may include all machines, transfer systems and personnel needed to manufacture a product. Students could be divided into groups, with each group responsible for the construction of one segment of the model.

Learning Check Sheet: PPC.006

Complete the following:

1. Name five things which would influence the layout design of a manufacturing plant:

   A.
   B.
   C.
   D.
   E.

2. Name three types of manufacturing systems:

   A.
   B.
   C.

3. The kind of product to be manufactured might determine the arrangement of the _____________ and ____________ in the plant.

4. A type of layout plan which arranges facilities into production groups to allow for easier control is known as a __________________.

5. The ___________________ would be a method used to move a product through a plant.

6. A _________________ layout is one in which work stations are arranged in groups that process families of parts that follow similar flow paths.

7. The order in which processes are completed on a product is known as the _______________________.

8. The aircraft industry would be a good example of a _________________ plant layout.

Discuss the following:

1. Explain the importance of developing a plant layout system for manufacturing a product.

2. Discuss several of the factors which must be considered in determining plant layout.

Learning Check Answer Key: PPC.006

1. A. Type of manufacturing system
   B. Kind of product being manufactured
   C. Kinds of manufacturing equipment and tools to be used
   D. Location of the manufacturing equipment and accessories
   E. Types of transfer systems

2. A. Custom
   B. Intermittent
   C. Continuous

3. Machines and equipment

4. Process layout

5. Transfer system

6. Cellular

7. Sequence of operations

8. Fixed

Performance Check: PPC.006

The instructor will evaluate the various steps of the plant layout exercise. Consideration will also be given to the justification for the layout design appropriate for the product being manufactured. The students will also be evaluated on test performance.

ACTIVITY NUMBER PPC.007

FLOW DIAGRAM FOR PRODUCTION

Description:

Flow diagrams are an important element of a plant layout plan. The materials and parts must follow a predetermined path through the manufacturing processes from start to finish in a production operation. This activity will help students to understand the importance of material flow through a plant and describe the various factors which affect the flow pattern. Students will be divided into teams to develop a flow diagram for manufacturing a product.

Rationale:

The efficiency of a manufacturing operation is affected to a great degree by the material flow pattern through the processing operations. It is important to design an effective flow diagram to minimize wasted time and activities during production.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Discuss the importance of developing a flow diagram.
2. Name and explain five of the factors which are critical to the develop of an effective flow diagram.
3. Design and develop a flow diagram for a product.

Tools, Materials, Machines and Resources:

1. Wright, R. T. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company.
2. Production technology (pamphlet). (1984). Macomb, IL: Western Illinois University, Department of Adult, Vocational, and Technical Education.
3. Factory (computer simulation activities). (1985). Pleasantville, NY: Sunburst Communications.
4. Copy of shop layout plan.
5. Access to shop facility for planning flow diagram.

Instructional Strategies:

The instructor will lecture about plant flow diagrams and discuss how they relate to the efficiency of production. Teams will be formed to develop a flow diagram for a product to be manufactured. The efficiency of the flow diagram will be evaluated with the groups. Various computer programs may also be used to simulate some of the activities in a manufacturing system.

Safe Practices:

Follow general shop safety rules when using the shop facility.

Integrative Skills

Communication:

x Reading
x Writing
x Speaking
x Listening

Computation:

x Fractions
x Decimals
x Percents

Personal

Teamwork (Interpersonal):

x Assertiveness
x Negotiation
x Listening
x Risk Taking

Change:

x Personal Adaption
_____ Professional Adaption

Computer:

x Operating Systems
x Keyboards
x Applications_____________________________

Decision Making:

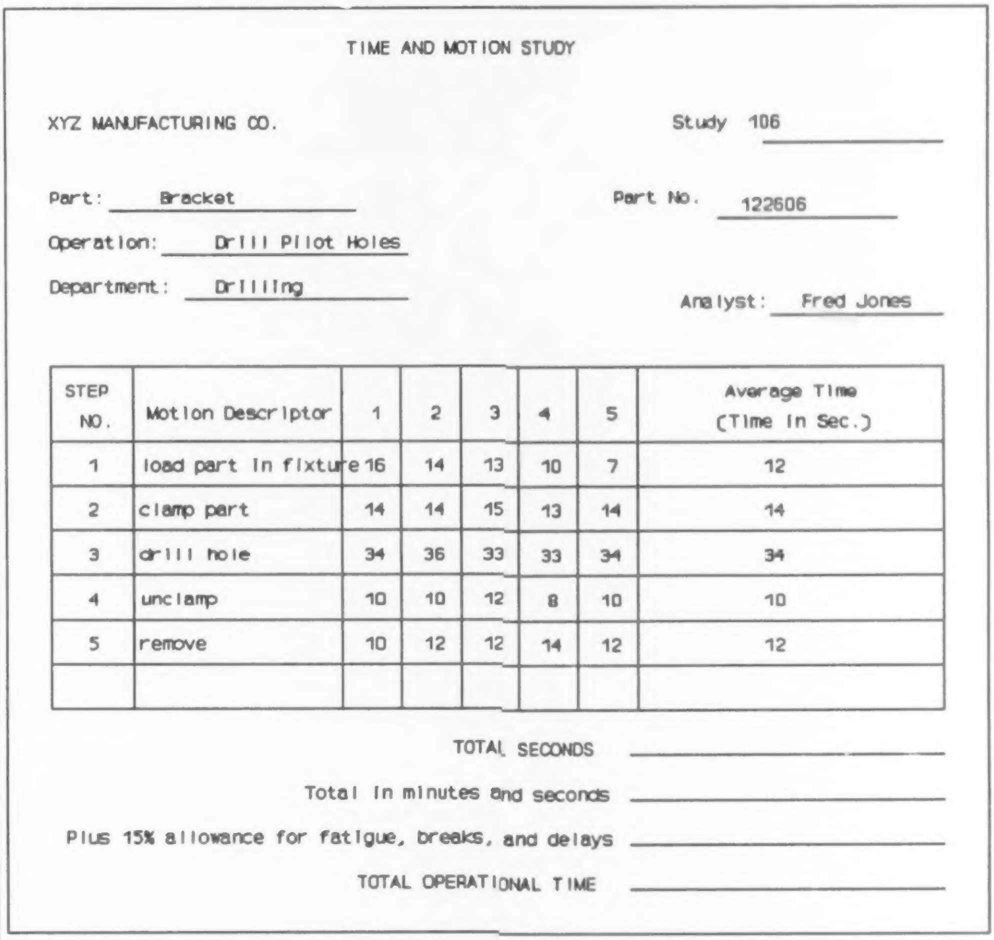
_____ Ethical Reasoning
x Logical Reasoning
x Flexibility

Problem Analysis:

x Identification
x Solutions
x Evaluation
x Implementation

The efficiency of a manufacturing system is affected by a number of variables. The process planning helps to determine what needs to be done to process a part. The plant layout establishes the location of machines and equipment so that the manufacturing processes can be accomplished as efficiently as possible. Another important factor in the processing of a product is the flow path that the materials and parts will follow from the beginning of the production cycle to the finished product. A **flow diagram** must be developed to determine how the materials will be processed. This acts as a road map for the production operations. The flow diagram, used along with the process plan and layout diagram, would be used to determine the location of equipment and work stations for processing the product. It would also show how the materials are to be transferred from one station to the next and the inspection points during the processing. Some of the equipment may need to be moved to improve the efficiency of the flow path. A code number would be provided for each task in the process. The specific machine would be identified and the tooling would be listed on the processing sheet. The flow diagram allows the engineers to study the sequence of operations and determine if there is a better way to make the part. They may analyze the movement of the work-in-process and determine if the lot size is correct to maximize product flow. This would allow for effective product and process control.

Some **line balancing** may be necessary to equalize the workload among the operators on a production line to minimize idle time. The cycle time of the product may be checked by utilizing **time and motion** studies (**see PPC.007/Fig. 13**), which accurately measure the time it takes to complete certain movements or operations and helps to incorporate the most efficient methods to complete an operation. One such technique, which was introduced in 1958 to increase the efficiency in government contracts, is known as the **Program Evaluation and Review Technique (PERT)**. This was used to decrease inefficiency in manufacturing processes. The PERT procedure develops a **critical path method (CPM)** of operations which is used to perform manufacturing processes with the most efficient movements possible. This involves a study of the movements of materials through processing to determine flow patterns and time factors. Material bottlenecks are many times a problem in the movement of materials. These are caused by either men or machines. There may be a need for more men or machines to create continuous flow.



TIME AND MOTION STUDY

XYZ MANUFACTURING CO.

Study 106

Part: Bracket

Part No. 122606

Operation: Drill Pilot Holes

Department: Drilling

Analyst: Fred Jones

STEP NO.	Motion Descriptor	1	2	3	4	5	Average Time (Time In Sec.)
1	load part in fixture	16	14	13	10	7	12
2	clamp part	14	14	15	13	14	14
3	drill hole	34	36	33	33	34	34
4	unclamp	10	10	12	8	10	10
5	remove	10	12	12	14	12	12

TOTAL SECONDS __________

Total in minutes and seconds __________

Plus 15% allowance for fatigue, breaks, and delays __________

TOTAL OPERATIONAL TIME __________

Every movement is timed in drilling pilot holes. Notice that allowance time on this form is a percentage of the time needed. Sometimes people are tired and work more slowly. Sometimes they take a break or there is a delay. Engineers must allow for this in their planning.

PPC.007/Fig. 13. Time and Motion Study
(PRODUCT AND PROCESS CONTROL, PPC.007)

A number of factors are used to determine flow patterns. The location of **equipment** and **work stations** will provide the most efficient flow of the materials through the processing activities. **Open space** requirements are also important. Enough room must be provided for personnel to operate the machines and to move the materials during processing. Sometimes storage space may be required for work-in-process. However, storage space is costly, so it must be kept at a minimum, or eliminated. The actual **movement of work-in-process** may be accomplished manually or with the use of conveyors or automated equipment. The **location of accessories** may also be a concern for material flow. Open access to such things as compressed air, electricity or water for use in processing, or to operate equipment may be necessary.

Departmental integration may be a key factor in achieving a smooth flowing operation. Many things come into play here, such as the size and weight of the machines being used, the type of process to be used, the accessibility of the equipment, the need for special accessories, the level of safety needed, and the utilities which are required. Another important factor in the location of the departments is the "team" concept of the entire operation. There must be frequent and fast communication between departments to insure proper quality control and processing. **Safety and job satisfaction** are additional considerations in the process plan. Every company must have a concern for its employees. By planning a process that will decrease boredom, insure employee safety, and keep employees near peak performance, the company will operate at a higher level of efficiency and productivity.

Flexibility in the design of the flow diagram and the layout design allows for product adaptability. This might be essential for quick changeover of products or changes in process requirements. Future trends must also be considered. Automated systems will no doubt be added to the processing operations. We can understand why a good flow diagram is essential for efficient production and why adequate time should be spent to analyze the flow of materials through the processing operations. This will allow for more effective product and process control during the processing stage of the manufacturing operation.

Student Activity Sheet: PPC.007

In this exercise, students will analyze the product process plan and determine the best flow path to be used for processing the materials. The students will form teams of 3 to 5 members and each team will develop a flow diagram. The flow diagram will be based on the production of a product in the school lab. A copy of the shop layout plan will be used in the development of the flow diagram. The layout plan developed in PPC.006 may be used for this exercise.

Use pencil lines to show the flow paths, so that changes can be easily made. Include the following information:

1. Flow lines showing material travel.
2. Transfer methods to move parts from one work station to the next.
3. Inspection points.
4. Work-in-process storage--keep in mind that some operations may take longer than others and materials may be backed up at certain points in the process.

Include some reference notes to help explain the flow diagram. Be prepared to discuss your diagram with the other teams.

Alternative Strategy for Activity Number: PPC.007

The students would be given an exercise in modifying an existing plant layout to develop flow diagrams for different types of products. The students will form teams to complete this exercise. The instructor will furnish each team with the same plant layout schematic. Each team will then be given a process sheet for a different type of product. The teams must then determine the best flow diagram to produce the product and decide what changes will need to be made to adapt the plant layout for production. (Students may also develop the process sheet for the product.)

Learning Check: PPC.007

Complete the following:

1. The path that materials will follow during processing is illustrated in the ______________________________.

2. A study of the time it takes to complete certain movements or operations during processing is called ______________________________.

3. ______________________________ is the equalizing of the workload on the production line to minimize idle time.

4. PERT was introduced to increase ____________________ in manufacturing processes.

5. The PERT procedure which develops the most efficient movements in a manufacturing process is known as ______________________________.

6. Name four of the factors which are used to determine flow patterns for processing a product:

   A.
   B.
   C.
   D.

7. In the development of a flow diagram, consideration must be given to the ______________ and ______________________________ of the workers.

8. The "team" concept to achieve more effective communication, safety and quick analysis of problems throughout the production area can be accomplished through ______________________________________.

Discuss the following:

1. Explain the importance of a flow diagram.

2. Explain why a flow diagram should have flexibility.

Learning Check Answer Key: PPC.007

1. Flow diagram
2. Time and motion
3. Line balancing
4. Efficiency
5. Critical Path Method (CPM)
6. A. Location of equipment and work station
   B. Open space
   C. Movement of work-in-process
   D. Location of accessories
7. Safety and job satisfaction
8. Departmental integration

Performance Check: PPC.007

The instructor will observe teams during their development of the flow diagrams. Individual input into the process will be assessed. Teams will be evaluated according to the efficiency of their diagrams and the justification of their decisions. Each student will be evaluated on test performance.

ACTIVITY NUMBER PPC.008

MATERIAL HANDLING SYSTEMS

Description:

Materials must be moved from one operation to the next in a manufacturing system. They must also be transferred from inventory or storage to the production area for processing. After production has been completed, the finished products must again be transferred to storage or shipped to the consumer. This exercise will give the students an understanding of the factors which determine the selection of material handling system and help them to realize the importance of these systems in the manufacture of a product. The student will develop a list of criteria for selecting a material handling system for producing a product.

Rationale:

Material handling systems are an important part of the manufacturing system. Efficient transfer of materials from one station to the next can improve the effectiveness of production. A thorough understanding of criteria for material handling systems is a key factor in the efficiency of material transfer in a manufacturing system.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of material handling systems in the manufacture of a product.
2. Discuss five of the factors which would have an effect on the movement of work-in-process.
3. Develop a list of criteria for determining the type of of material handling system to be used in a production operation.

Tools, Materials, Machines and Resources:

1. Groover, M. P. (1980). Automation, production systems, and computer-aided manufacturing. Englewood Cliffs, NJ: Prentice-Hall, Inc. (pp. 65-92)
2. White, J. A. (1987). Production handbook. New York: John Wiley & Sons, Inc. (pp. 100-127)
3. Wright, R. T. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company. (pp. 168-178)
4. Plant layout, product process plan and flow diagram for a manufacturing system.
5. Field trip to local manufacturing plant.

Instructional Strategies:

The instructor will lecture about criteria for material handling systems used in various plant layouts and conduct a class discussion on the topic. Students will work in groups to develop a list of criteria for selecting material handling systems.

Safe Practices:

No safety hazards in this unit of study.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Materials for manufacture are usually moved through three areas of a production system. They must first be moved from the incoming materials or storage area to the processing center. They must then be moved from station to station through the work-in-process area. Finally, the materials must be moved to finished product storage or the outgoing materials shipment area. Different types of material handling systems must be used for each stage of the process. **Material handling systems** are any means by which materials are moved through a production system. This may be accomplished manually or by means of very sophisticated automated systems.

There are several factors which affect the selection of the material handling system to be used. The **size and shape of the materials** to be moved is an obvious one. These will determine the size of equipment needed to carry the materials. Independent motorized vehicles may be used or the materials may be transported directly from storage to processing by a conveyor system. Sometimes, the materials may even be carried manually.

The amount of **floor space** available is another consideration for material handling. The type of manufacturing system is sometimes much more adaptable to a specific method of transfer. In a line system, for example, the materials or parts may be constantly moving along an automated line for processing, while in larger product manufacture, fork lift trucks or cranes may be needed to move the materials. In the tool and die industry, small die parts are simply hand carried from one machining area to the next. For larger parts, there would need to be adequate spacing between work stations for vehicles, such as fork lifts, to maneuver when transporting materials. Floor space, however, has become very expensive and would best be kept at a minimum.

The specific **type of material handling system** to be used is the main consideration in material transfer. A **manual** type system may be used in which the materials and parts are carried by the workers. In a **motorized vehicle** system, the materials would be moved by some type of vehicle operated by one of the workers. Another method used to move parts and materials would be a **conveyor system**. Materials and parts usually move freely on conveyors without worker assistance. The last method of material transfer is the use of an **automated** system. This type is usually computer controlled and needs very little human intervention.

Employee safety is another factor in the transfer of materials.. Regardless of the type of material handling system being used, there must be a control factor for employee safety. Some of the automated systems may provide more safety in moving materials because there is less chance of human error. Safety systems built into the transfer equipment also provide a higher level of safety control.

Cost effectiveness and **time efficiency** must be considered in transfer of materials. The larger more highly automated systems will be more expensive to install and require more constant maintenance, but the level of efficiency and reliability will be higher. The automated system may also offer a higher level of both product and process control.

There are three main **control functions** for material handling systems. **Sequence control** coordinates the sequence of actions of the transfer system and its work stations. The operations on one part must be completed before the next part is begun. This is more easily coordinated in an automated system, since each successive operating system may be activated by the previous one. **Hazard monitoring** is a control function that ensures that the transfer system does not operate in an unsafe condition. This may involve the use of sensors to control machining operations, monitor critical steps in processing or control equipment operating functions, such as hydraulic or air pressure. The third control function is **quality monitoring**. This is used to control the quality attributes of the work part. Quality monitoring may be used for inspection purposes. Various types of **vision systems** may be used to monitor quality. A vision system may identify whether a part will be rejected or accepted or simply indicate whether a part is in place for processing.

The primary function of control systems is not to just simply stop and start a material handling system in the event of a failure. There may be situations where it would be very costly to shut down an entire system. It may be better to lock out the affected area and continue the operation of the system. Many of the automated systems have a built-in diagnostic control to assist in immediate detection of the malfunction. The material handling system is an important part of product and process control. The correct processing of the parts, as well as the efficient movement of the parts through the processing operations, is critical to the overall effectiveness of the work-in-process segment of the manufacturing system.

Student Activity Sheet: PPC.008

In this exercise, students will determine the criteria to be used for setting up a material handling system for manufacturing a product. The students will form teams of 3 to 5 members. Each team will be supplied with information about the type of product to be manufactured. The teams will also be given a process plan for the product, and a plant layout plan and a flow diagram to be used for the exercise. The layout plan will not include any transfer systems.

The teams will then analyze the information they have received and develop a list of criteria to be used to determine the types of material handling systems to be used in the three main areas of the manufacturing operation. They will also determine the points at which a material handling system must be used. The students must be sure to consider the layout of the machines and the product flow path. The students may recommend the relocation of any equipment which is easy to move. You may also make changes in the flow diagram to allow for more effective use of a material handling system.

Be sure to include explanations as to why a handling system would be needed at a particular location. After the lists have been completed, each team will present a plan to the group for discussion.

Alternative Strategy for Activity Number: PPC.008

The students will visit a local company individually or on an organized field trip. Each student will analyze the company's manufacturing operation and write a report explaining the criteria for material transfer. The reports could be shared with the entire group. The group could also discuss the criteria for determining the type of material handling system to be used.

Learning Check Sheet: PPC.008

Complete the following:

1. Materials are moved through a production by using a ______________ ____________________.

2. Name five factors which affect the selection of a material handling system and give an explanation of each.

   A.

   B.

   C.

   D.

   E.

3. Name four types of material handling systems.

   A.

   B.

   C.

   D.

4. Name and explain the three main control functions for material handling systems.

   A.

   B.

   C.

Learning Check Answer Key: PPC.008

1. Material handling system

2. A. Size and shape of materials
   B. Floor space
   C. Type of material handling system
   D. Employee safety
   E. Cost effectiveness and time efficiency

3. A. Manual
   B. Motorized vehicle
   C. Conveyor
   D. Automated

4. A. Sequence control
   B. Hazard monitoring
   C. Quality monitoring

Performance Check: PPC.008

The instructor will evaluate the criteria lists submitted by each team. The teams will also be evaluated on the presentation of their plans. The individual input of each student will be observed. The students will be evaluated on test performance.

ACTIVITY NUMBER PPC.009

MATERIAL TRANSFER THROUGH PRODUCTION

Description:

The material handling equipment to be used in a manufacturing system usually consists of several different types of transfer vehicles. Materials must be moved into the production area, from one work station to the next and into the finished goods storage area. The criteria used for the selection of this equipment have already been discussed. This exercise will familiarize the student with the different types of equipment used to transfer materials and explain why they are used. The students will use the team approach to develop a schematic showing the type of equipment used and its location in a production system.

Rationale:

Material handling equipment is essential for moving parts and materials through a manufacturing system. The type of equipment and its location may be key factors in the efficiency of a production operation.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Describe several types of equipment use for handling materials in a production system.
2. Identify and explain several methods for transferring materials to and from the production area and from work station to work station during processing.
3. Determine the types of material handling equipment needed for producing a given product.
4. Develop a schematic of the material handling systems used in a production operation and show their respective locations on a flow diagram.

Tools, Materials, Machines and Resources:

1. Groover, M. P. (1980). Automation, production systems, and computer-aided manufacturing. Englewood Cliffs, NJ: Prentice-Hall, Inc.
2. White, J. A. (1987). Production handbook. New York: John Wiley & Sons, Inc.
3. Wright, R. T. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company.
4. Manufacturing systems technology (video). (1989). Garden City, NY: Bergwall Productions.
5. Autocad (Apple computer program). (1988). Autodesk Company.
6. Floor plan (Apple computer program). Chatsworth, CA: Career Aids.
7. Robot assembly lab (Apple computer program). (1988). Westerville, OH: Kitchen Sink Software, Inc.
8. Scorbot robot programming (IBM/Apple). (1987). Morse, IL: Aidex Corporation.
9. Product process plan, flow diagram, and graph paper.
10. Field trip to local manufacturing plant.

Instructional Strategies:

The instructor will discuss material handling equipment and applications with the students. A film or video may be shown illustrating the use of some of the transfer systems used in industry. Students will work in groups to develop a schematic showing the type and location of material handling equipment used in a production operation.

Safe Practices:

No safety hazards in this unit of study.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications________________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

Material handling systems consist of a variety of different types of equipment which are used to move materials and parts throughout a production system. In PPC.008, four categories of material handling equipment were discussed. The **manual** type system might be as simple as workers carrying materials from one work station to the next. An example of this would be the tool and die industry, where small die parts are hand carried from one machining area to another. Materials may also be moved manually by using hand trucks, carts or parts wagons which are pushed or pulled around the production area. This system is most often used for transporting smaller parts.

The **motorized vehicle** type of system is one where materials are moved by some type of powered vehicle operated by a worker. The motorized vehicles would include such things as hoists and cranes, some of which may be mounted on large overhead rails, for moving larger parts or pallets of materials. Some materials are palletized, which means that they are stacked or packaged together on a wooden platform or carrier of some type so that they can all be moved at one time. Industrial trucks, such as fork lifts, are also used. However, these types of motorized vehicles require a larger amount of open space between machines and equipment so that can be used to move materials freely. Sometimes these types of vehicles are only used to move materials from the storage area to the beginning of the production area or to move finished products from the end of the production line to finished parts storage or the shipping area. This would not require open spaces to be available around the work stations. Motorized hand trucks or transport lifts might also be used to move parts.

A third type of system, which is a more stationary and sometimes permanent system, is the **conveyor**. These are one of the largest families of materials handling equipment. Conveyors can be used to handle individual items, packages, containers, or unitized loads. They are not only used to move materials, but can also be used to accumulate, sort, and provide in-process storage. Conveyors can be mounted flush with the floor so that other vehicles can move over them, above the floor, or overhead. This provides extensive flexibility for materials transfer. Conveyors can also be used to move materials from storage into the production area, through production and on to the finished products storage area.

The last type of material handling equipment to be discussed is the **automated system**. The traditional symbol of automation is the mechanized flow line. This type of system was greatly improved and modified by Henry Ford in his automobile assembly lines; however, Henry Ford did not invent the system. Because of its extensive use in the automotive industry, this type of mechanized production is often referred to as **Detroit automation.** Flow lines are generally used in manufacturing systems that have relatively stable product lines and high rates of productions. Flow lines may be in a straight line configuration, known as in-line systems with work stations arranged in a straight line, or they may be a rotary type in which a circular parts carrier moves materials to work stations arranged around the carrier. Other types of equipment in an automated system may include a series of robot arms which move parts from one work station to the next. A production line may also be set up with a very complex computerized materials transfer system using a variety of different types of equipment. One example would be an automated storage and retrieval system (ASRS) used to move materials into the production area. Another example would be the automatic guided vehicle system (AGVS) which can be used to move materials anywhere in the plant using a computerized system.

The material handling devices may be a **fixed path** type or **variable path** type. The fixed path device moves materials from one point to the next, always traveling on the same path. Examples of fixed path devices would be conveyors, pipes, chutes, and elevators. The "pick-and-place" robot would also be considered a fixed path device. The variable path devices can be controlled or steered. Some examples would be forklifts, overhead cranes and tractors. While many of these require operators, variable path robots are usually controlled by a computer and may follow wires buried in the floor.

One, or a combination of these types of material handling equipment, may be used in a manufacturing system. The selection depends largely on the plant layout and the flow plan for the product being produced. The system and equipment which offer the greatest efficiency and the most flexibility should be chosen for the manufacturing operation.

Student Activity Sheet: PPC.009

This exercise will give students some experience in the selection of different types of material handling equipment to be used in a manufacturing system. The students will form teams of 3 to 5 members and obtain the necessary materials from the instructor. The teams will be given a plant layout sheet and a flow diagram. Each team will analyze the information and determine which types of equipment will best meet the needs for the production system. Remember to include equipment used to transfer materials from the incoming materials storage area to the production area, the movement of materials from work station to work station in the processing area, and the transfer of finished goods to the shipping or finished goods storage area. Be sure to consider floor space allocations, size and shape of materials, and types of operations to be performed.

Each team will then develop a schematic showing the location of all material handling devices to be used in each area and label the various types of equipment.

Each team will present its plan to the entire group for discussion. The group will then decide on the best plan to be used in the manufacturing process.

Alternative Strategy for Activity Number: PPC.009

Activity #1

The students will form teams and select different types of manufacturing systems. They will evaluate and analyze the different types of material handling devices used in the system they choose. They will write a description of the device and an explanation of why that device was being used for a given application. They might also offer suggestions for improvements in the system. This information will be presented to the entire group. The various types of material handling systems will be discussed.

Activity #2

The students will form teams and construct a gravity feed system or conveyor system. This could be incorporated into a unit on Robotics.

Learning Check Sheet: PPC.009

Match the following:

__1. Conveyor

__2. Detroit automation

__3. Motorized vehicle

__4. Fixed path

__5. Forklift

__6. Automated system

__7. Hand truck

__8. Variable path

__9. Manual

__10. ASRS

__11. Pick and Place

__12. AGVS

A. An automated system which removes materials from storage moves them into production.
B. A type of material handling system in which workers move parts by hand.
C. A fixed path robot used to move materials.
D. A type of material handling system on which parts always travel the same path and are usually fixed in place.
E. An automated device which moves materials through production using a computerized vehicle system.
F. Mechanized flow line production.
G. A type of motorized vehicle used to lift and move parts.
H. Any type of device which only moves parts from one point to the next, always traveling on the same path.
I. Any type of device which can be controlled or steered.
J. A type of material handling device used to move parts by hand.
K. A type of material handling system which uses computerized equipment to move materials.
L. A type of material handling system in which parts are moved on vehicles operated by workers.

Learning Check Answer Key: PPC.009

1. D
2. F
3. L
4. H
5. G
6. K
7. J
8. I
9. B
10. A
11. C
12. E

Performance Check: PPC.009

The instructor will evaluate each team's schematic showing the types of material handling equipment to be used in the production of a product. Each student's input into the project, presentation, and discussion will be evaluated. The students will also be evaluated on test performance.

ACTIVITY NUMBER PPC.010

WORK-IN-PROCESS CONTROL

Description:

There are a number of control factors which affect the work-in-process segment of manufacturing. Shop floor control and shop communications are critical to the effectiveness of the production operation. In this exercise, the various factors that affect work-in-process will be studied. The student will become familiar with these factors and understand why they have an effect on production.

Rationale:

The production control function is a key factor in the manufacturing system. This is the process which coordinates men, machines, and materials to produce a product with the optimum profit. A familiarization with the factors which control work-in-process will give the student a better understanding of how the production process operates.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of maintaining close control in the production area.
2. Discuss the difference between shop floor control and shop communications.
3. Develop a list of factors which must be considered in the control of work-in-process.

Tools, Materials, Machines and Resources:

1. Greene, J. H. (1984). Operations management productivity and profits. Englewood Cliffs, NJ: Reston Publishing Company/ Prentice-Hall.
2. Groover, M. P. (1987). Automation, production systems, and computer-integrated manufacturing. Englewood Cliffs, NJ: Prentice-Hall, Inc.
3. Wright, R. T. (1985). Exploring manufacturing. South Holland, IL: Goodheart-Willcox Company.
4. Buhrke, P. (1988). Quality control manual (pamphlet). Arlington Heights, IL: Buhrke Industries, Inc.
5. Manufacturing systems explained (video on controls and outputs in production). (1989). Garden City, NY: Bergwall Productions.
6. Forms used to maintain work-in-process control (included in this unit).

Instructional Strategies:

The instructor will lecture about the factors which affect work-in-process. The group will discuss the methods of control used to maintain the production process. Shop floor control and shop communications will be discussed. The students will form two groups. Each group will develop a list of factors which must be considered in the control of work-in-process. The two groups will debate their findings with the instructor acting as mediator.

Safe Practices:

No safety hazards in this unit of study.

Integrative Skills

Communication:

x Reading
x Writing
x Speaking
x Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

x Assertiveness
x Negotiation
x Listening
x Risk Taking

Change:

x Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
x Logical Reasoning
x Flexibility

Problem Analysis:

x Identification
x Solutions
x Evaluation
_____ Implementation

The control of work-in-process involves two main areas of concern. These are shop floor control and shop communications control. The controls related to the processes involved in completing a product will be discussed. The next unit will deal with the controls related to the product. Every system must have a feedback closed-loop control designed into it for effective operation.

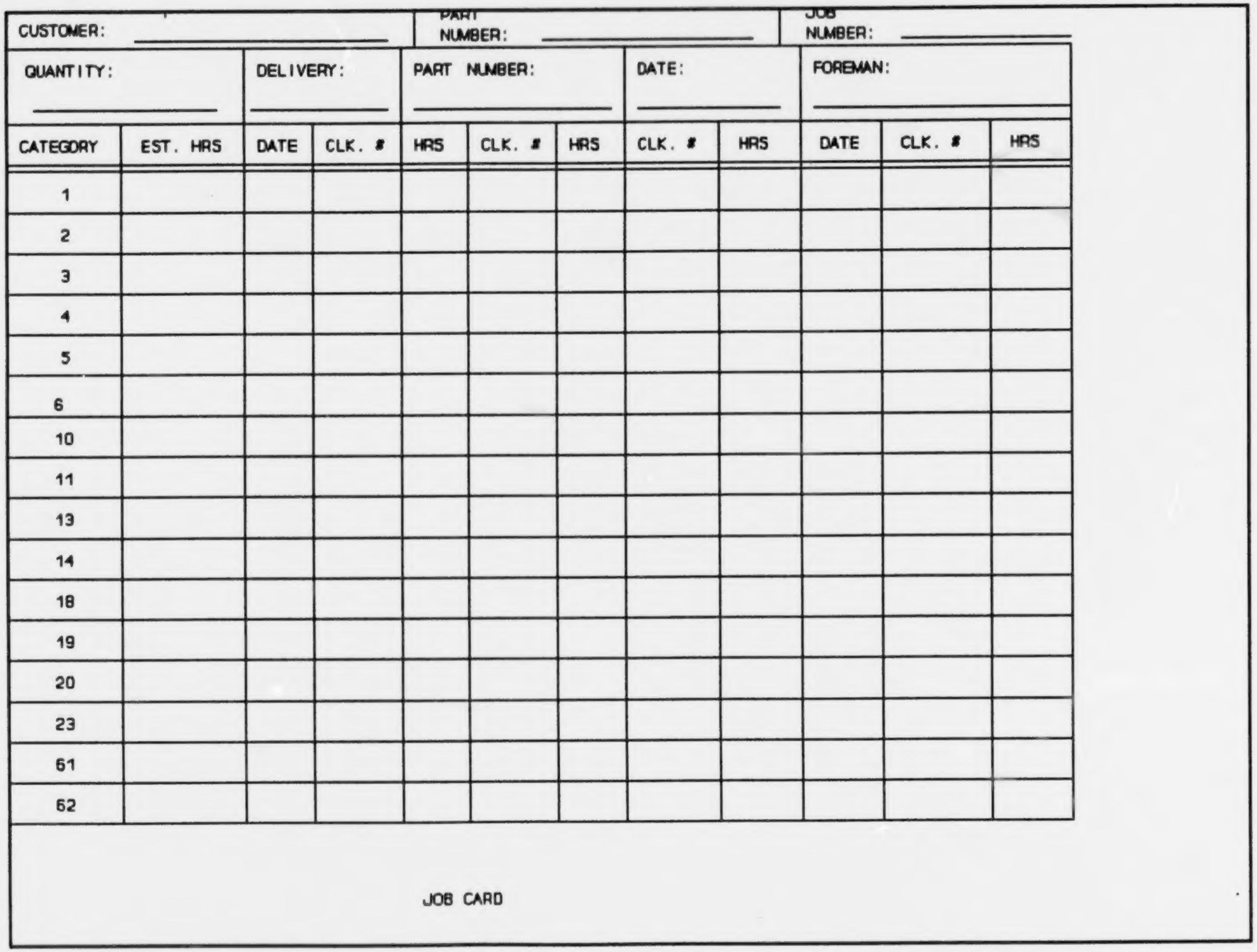
A typical shop floor control system has three phases. In a system which uses **computer integrated manufacturing (CIM)**, a greater level of control is accomplished in each of these phases. These three phases include: **order release, order scheduling and order progress.**

The **order release** phase provides the documentation needed to process the product. This documentation might include a **material routing sheet**, which is the operation sheet information needed to determine which processes are to be done. It would also include **material requisitions** to draw materials from the inventory, and **job cards (see PPC.010/Fig. 14**) to report direct labor time used during the processing of the order. The job card would also indicate the progress of the order through the factory. **Move tickets (see PPC.010/Fig. 15)** would be included to authorize the material handling personnel to transport parts between work centers if required. There may also be a **parts list** if the job required assembly work.

The **order scheduling** phase assigns the production orders to the various work centers in the plant and schedules the operations to be performed. It also provides information about priorities of different jobs and is intended to solve two main problems in production: the **machine loading** problem and the **job sequencing** problem. Machine loading is the amount of work or jobs assigned to a work center in a given time period. This develops what is known as the **queue** of work waiting to be processed. These processing queues are a constant problem for managers. Job sequencing is the determining of an order in which the jobs will be processed through a given work center. A priority control must be established to deal with such things as due dates and processing time.

The **order progress** phase monitors the status of the various orders in the plant. This provides useful information for managing the production operation. The order progress reports include such things as **status information**, which indicates the stage of process the work is in, the processing hours remaining, whether the job is on schedule and the level of priority. The report also includes the **performance rating** of the shop during a certain time period. The report compares the amount of work that could be completed to the amount of work that was actually completed. **Exception reports** are also a part of order progress. These show the number of deviations from the production schedule. This information is useful to management in making decisions as to allocations of resources, authorization of overtime hours, and in identifying any problems that might be affecting the production schedule.

PPC.010/Fig. 14. Job Card
(PRODUCT AND PROCESS CONTROL, PPC.010)

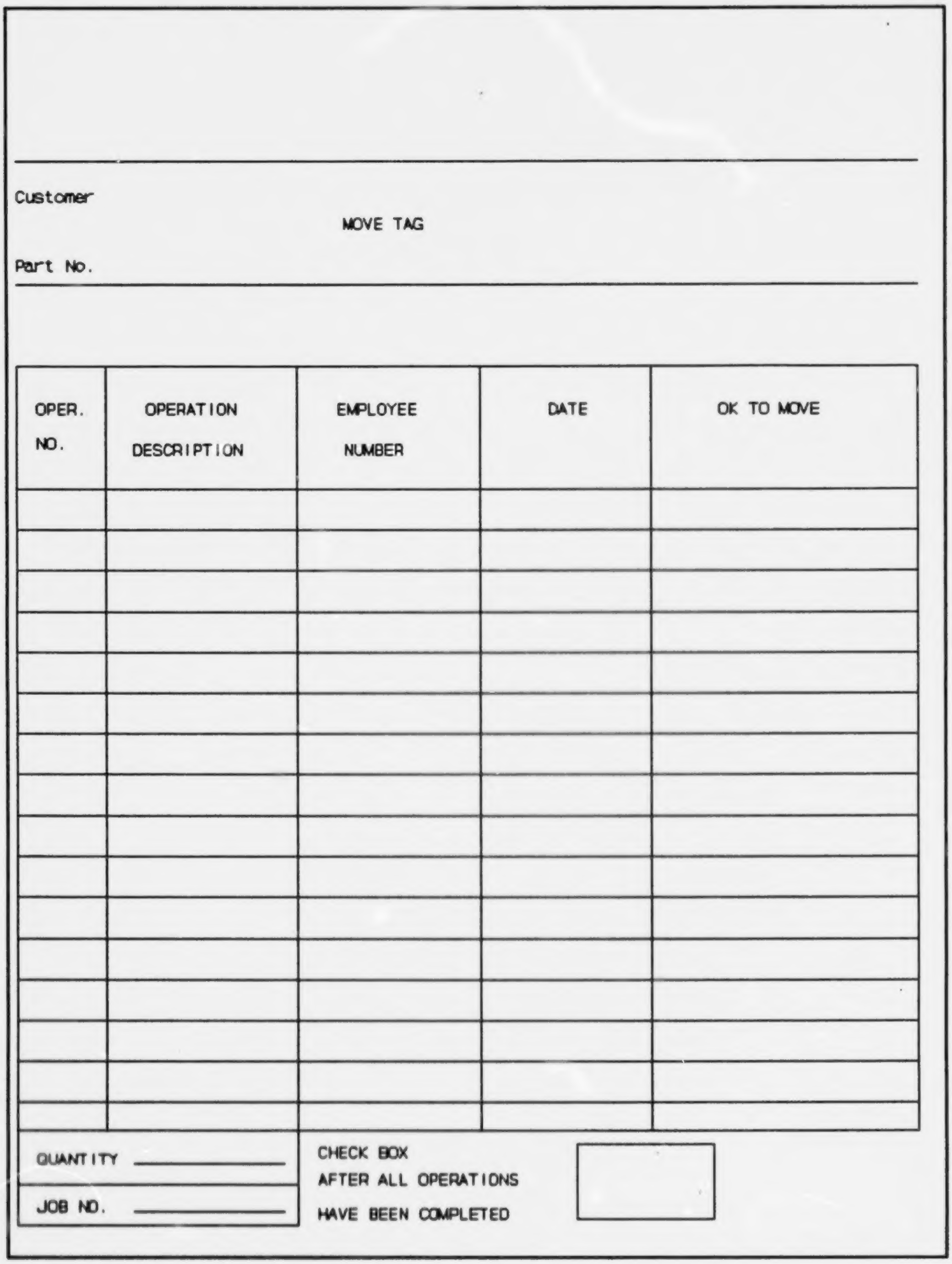


CUSTOMER: ____________ PART NUMBER: ____________ JOB NUMBER: ____________

QUANTITY: ____________ DELIVERY: ____________ PART NUMBER: ____________ DATE: ____________ FOREMAN: ____________

CATEGORY	EST. HRS	DATE	CLK. #	HRS	CLK. #	HRS	CLK. #	HRS	DATE	CLK. #	HRS
1											
2											
3											
4											
5											
6											
10											
11											
13											
14											
18											
19											
20											
23											
61											
62											

JOB CARD



Customer

MOVE TAG

Part No.

OPER. NO.	OPERATION DESCRIPTION	EMPLOYEE NUMBER	DATE	OK TO MOVE

QUANTITY ______________

JOB NO. ______________

CHECK BOX
AFTER ALL OPERATIONS
HAVE BEEN COMPLETED ☐

PPC.010/Fig. 15. Move Ticket
(PRODUCT AND PROCESS CONTROL, PPC.010)

A great deal of planning is involved in the control of work-in-process. Most manufacturing companies are concerned with two main areas of planning. The first is **capacity planning**, which is the capacity available during some period of time. The second is **production planning**, which is the capacity needed during a period of time. These planning processes require large staffs of clerical personnel and many hours of planning time. Many of the large manufacturing companies have adopted computerized planning systems. Some examples of these systems are: **computer-aided process planning (CAPP), computer integrated production planning (CIPP) and material requirements planning (MRP).** All three are systems used to accomplish some form of capacity planning. This would usually include the **load**, which is the amount of work scheduled ahead in hours or units of production; the **schedule**, which is the starting and completion times for materials; and the **capacity**, which is the actual rate of processing. Once these are determined, the production plan can be developed. After the processing has begun, continuous monitoring is required to determine what adjustments need to be made to maintain an efficient rate of production.

The second area of concern in the control of work-in-process is **shop communications**. A feedback closed-loop control is also essential in this area to maintain control. Communication must be maintained in many areas within the manufacturing system. Engineering must communicate product changes to the shop floor, as well as the production area, communicating the need for design or process changes for more effective production. Supervisors may need to communicate a change in job sequence to reduce queues or meet production deadlines. The tool department may have tool delays which will require a change in the sequencing of orders at a particular work station. Quality control may need to inform production personnel that incoming materials do not meet specifications, or that work-in-process is not meeting required standards. Purchasing may anticipate a delay in material orders which will affect the start time of a job. The sales personnel may have to inform management that certain orders need to be speeded up, slowed down or cancelled. All these situations have a direct effect on the production operation. Production control is the hub of communications for factory operations and must be monitored continuously.

Maintaining an efficient and effective rate of work-in-process is not an easy job. It requires input from all areas of the manufacturing system and must be coordinated with the proper timing and accuracy to improve productivity and profits.

Student Activity Sheet: PPC.010

The students will be divided into two groups. These groups will act as two production planning teams. After reading the information sheets and listening to the lecture information, each team will develop a list of factors which must be considered in the control of work-in-process for a given type of product. Remember to consider shop floor control as well as shop communications.

The instructor will act as a company vice president in charge of operations. The instructor may develop simulated situations which may arise during the production process. Each team will offer suggestions to solve the problems at hand and discuss its ideas on production control. The teams will write down their lists of control factors and solutions to problems which may be given by the instructor.

Alternative Strategies for Activity Number: PPC.010

The students will research the different methods used by companies for work-in-process and production control. They will include some of the more current computerized systems which are being used. Sources may include the library, periodicals, or managers from local companies.

Learning Check Sheet: PPC.010

Complete the following:

1. The two main areas of control for work-in-process are ______________ and ________________ .

2. Name the three phases of shop floor control.

   A.
   B.
   C.

3. The ____________________ assigns the production orders to the various work centers and schedules the operations to be performed.

4. __________________ is the amount of work assigned to a work center in a given time period.

5. The determining of the order in which the jobs will be processed through a given work center is known as ________________________.

6. The ____________________ monitors the status of the various orders in the plant.

7. __________________ is a report of the efficiency of shop operation over a given period of time.

8. __________________ shows any deviations from the production schedule.

9. The ____________________ provides documentation which is needed to process the product.

10. A form which shows the operation information needed to determine the processes to be completed on a product is the ______________ _____________________.

11. ____________________ are used to draw materials from the inventory.

12. List and explain the two main areas of planning for manufacturing companies.

    A.

    B.

13. Name two examples of computer automated systems used for production planning in manufacturing companies.

A.
B.

14. State five examples of the areas and types of communication that would be critical to production effectiveness.

A.
B.
C.
D.
E.

Discuss the following:

1. Explain the importance of maintaining close control in the production area.

2. Discuss the difference between shop floor control and shop communications.

Learning Check Sheet Answer Key: PPC.010

1. A. Shop floor
   B. Shop communications

2. A. Order release
   B. Order scheduling
   C. Order progress

3. Order scheduling

4. Machine loading

5. Job sequencing

6. Order progress

7. Performance rating

8. Exception reports

9. Order release

10. Material routing sheet

11. Material requisitions

12. A. Capacity planning
    B. Production planning

13. A. Computer Aided Process Planning (CAPP)
    B. Material Requirements Planning (MRP)
    (also)
    C. Computer Integrated Production Planning (CIPP)

14. A. Engineering - Design problems
    B. Shop floor supervisors - Job sequencing changes
    C. Quality Control - Non-conforming materials
    D. Purchasing - Delays in material orders
    E. Tool Department - Tooling delays
    (also)
    F. Sales - Change in product demand
    G. Production - Design changes in product needed

Performance Check: PPC.010

The instructor will evaluate each planning team's list of production control factors. Individual students will be evaluated on the extent of their input into the discussion process. The teams will also be evaluated on their justifications for their solutions to production problems. Each student will also be evaluated on test performance.

ACTIVITY NUMBER PPC.011

QUALITY STANDARDS FOR WORK-IN-PROCESS

Description:

Product control is an important part of the production control process. The product must be continually monitored during the various operations which must be performed to meet required specifications. A level of quality control must be set according to the customers' demands and to meet the manufacturer's company standards. Students should be aware of how product and process control is maintained on work-in-process. This exercise will give students some experience in applying quality control standards on work-in-process.

Rationale:

Quality control is a critical function for a company to maintain its productivity and profit levels. Product and process quality control levels must be established above customer expectations to minimize the number of reject products. Students should understand the product and process control functions of a manufacturing company.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of product and process quality control.
2. Identify and explain some of the quality control methods used in production.
3. Discuss some of the procedures used to minimize product defects.
4. Establish a quality control procedure to be used for a product and identify some of the quality checks to be made.

Tools, Materials, Machines and Resources:

1. Besterfield, D. H. (1979). *Quality control*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
2. Feigenbaum, A. V. (1983). *Total quality control* (3rd ed.). New York: McGraw-Hill.
3. Groover, N. P. (1987). *Automation, production systems, and computer-aided manufacturing*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
4. Schonberger and Knod. (1988). *Operations management*. San Diego: Business Publications, Inc.
5. Buhrke, P. *Quality control manual* (pamphlet). (1988). Arlington Heights, IL: Buhrke Industries, Inc.
6. *Quality in quantity* (film on quality control). New York: National Association of Manufacturers.
7. Quality control forms (included in this unit).

Instructional Strategies:

The instructor will discuss various methods of product control and some of the quality control checks used in manufacturing. The students will form two quality assurance teams and establish quality control procedures. The teams will present their findings and the group will discuss the results.

Safe Practices:

No safety hazards in this unit of study.

Integrative Skills

Communication:

☒ Reading
☒ Writing
☒ Speaking
☒ Listening

Computation:

☒ Fractions
☒ Decimals
☒ Percents

Personal

Teamwork (Interpersonal):

☒ Assertiveness
☒ Negotiation
☒ Listening
☒ Risk Taking

Change:

☒ Personal Adaption
☐ Professional Adaption

Computer:

☐ Operating Systems
☐ Keyboards
☐ Applications______________________________

Decision Making:

☐ Ethical Reasoning
☒ Logical Reasoning
☒ Flexibility

Problem Analysis:

☒ Identification
☒ Solutions
☒ Evaluation
☒ Implementation

Product control involves many different inspection and testing procedures. The control of product quality may be accomplished by the direct measurement of a part during or after production, or by controlling and adjusting the processing operations used to make the product. A. V. Feigenbaum, in his book Total Quality Control, states that "the burden of proof for quality rests with the makers of the part." In today's concept of **total quality control**, the primary responsibility for quality goes to the operations department. The other areas of quality control in a company have secondary responsibility. Feedback is an important part of total quality control. When a defect is found, the source of the problem should be determined immediately and corrective action taken. **Corrective action** is the procedure taken to remedy the source of the problem causing the defect. As materials are processed, they should be inspected at various stages. This helps to minimize the possibility of defective goods reaching the consumer. Work-in-process is divided into various stages. These stages are **rejects, rework, and acceptable items.**

Rejects are any items failing to meet standards. These items cannot be repaired and usually end up as scrap parts. Rejects can be caused by several things. One may be **material defects.** This can usually be corrected by closer inspection of incoming materials. These so-called **nonconforming materials** can be isolated before they enter into the production cycle. **Machine error** may be another cause of rejects. Machines and tooling can be adjusted to reduce machine inaccuracies. A procedure known as **preventive maintenance** helps to minimize machine error. This is a process where machines are checked and adjusted periodically to insure that they are operating properly, or they may even be shut down so that parts may be changed before they break. This would be a form of **process control,** in which the machines or operations are controlled so that they maintain quality production. The third cause of rejects may be due to **operator error.** Operators sometimes make mistakes on the job. Workers may need more training or closer supervision.

Reworks are items failing to meet standards. These items can be repaired. However, rework can be costly to a company's operation and must be kept to a minimum.

The third stage of work-in-process is **accepted work.** These are items which meet the required specifications of production. Final products must meet quality standards. Some may be visually inspected, while others require inspection by precision tools or machines. Their size and performance may be checked by means of a series of nondestructive tests. Products are not damaged using this type of test. Destructive testing, on the other hand, destroys the product as it is tested. These are forms of **product control,** in which the parts being produced are controlled to maintain finished product specifications.

The **frequency of inspection** is usually determined by the type of product being processed or by the quality control standards required by a customer. Some products, such as stampings, require a **first-run piece** and a **last-run piece** inspection to insure that a machine set is correct. **Periodic part checks** are then made during the stamping process. Other products may require a 100% inspection, which means that every part must be thoroughly inspected.

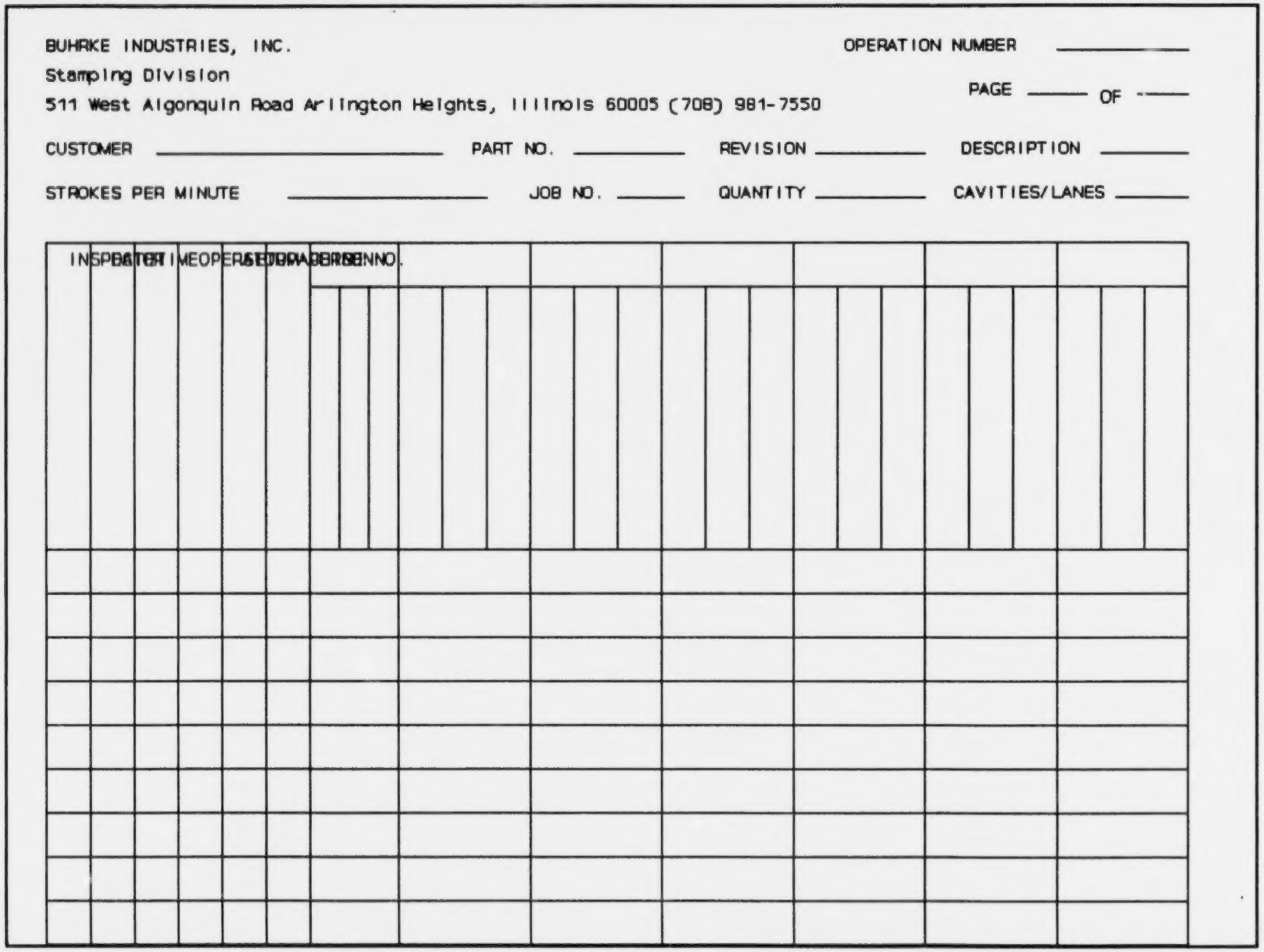
In-process inspection is the inspection of parts while they are being produced. This may be accomplished in a number of ways. Some of these inspection methods are as follows:

1. Visual--inspecting surface finish or basic form of a part.
2. Gauging--comparing a part or operation on a part with a known size of standard, such as a plug gauge or "go and no-go" gauges.
3. Measurement tools--direct measurement using the following tools: nonprecision, such as a machinist's scale or calipers; precision-hand tools, such as micrometers, dial calipers, or vernier height gauges; and electronic devices, such as optical comparators, microscopes, or profilometers.
4. Sensors for automated inspection--computer controlled measurement equipment, such as coordinate measuring machines (CMM), flexible inspection systems, and inspection probes.
5. Optical--the interpretation of image data by a computer, such as vision systems and scanning laser systems.

These inspection instruments allow for quality control by checking size variations of parts. This may be done by the machine operator while the part is being processed, or it may be done by taking the part to a special inspection area for more in-depth control measures. This information is then recorded on an In Process Inspection Report (**see PPC.011/Fig. 16**).

There must also be a level of control on the inspection instruments as well. The quality level of the inspection instruments must be greater than the specifications on the product to maintain production standards. All quality control instruments must be calibrated periodically--some more often than others. Precision hand tools used by workers should be calibrated several times a day or more often if the situation requires. Other larger pieces of equipment will have calibration specifications set up by the company. Each gauge will have a record card (**see PPC.011/Fig. 17**) for quality control purposes which will indicate calibration levels of accuracy, dates of calibration, and other control information.

PPC.011/Fig. 16. In Process Inspection Report
(PRODUCT AND PROCESS CONTROL, PPC.011)



BUHRKE INDUSTRIES, INC.
Stamping Division
511 West Algonquin Road Arlington Heights, Illinois 60005 (708) 981-7550

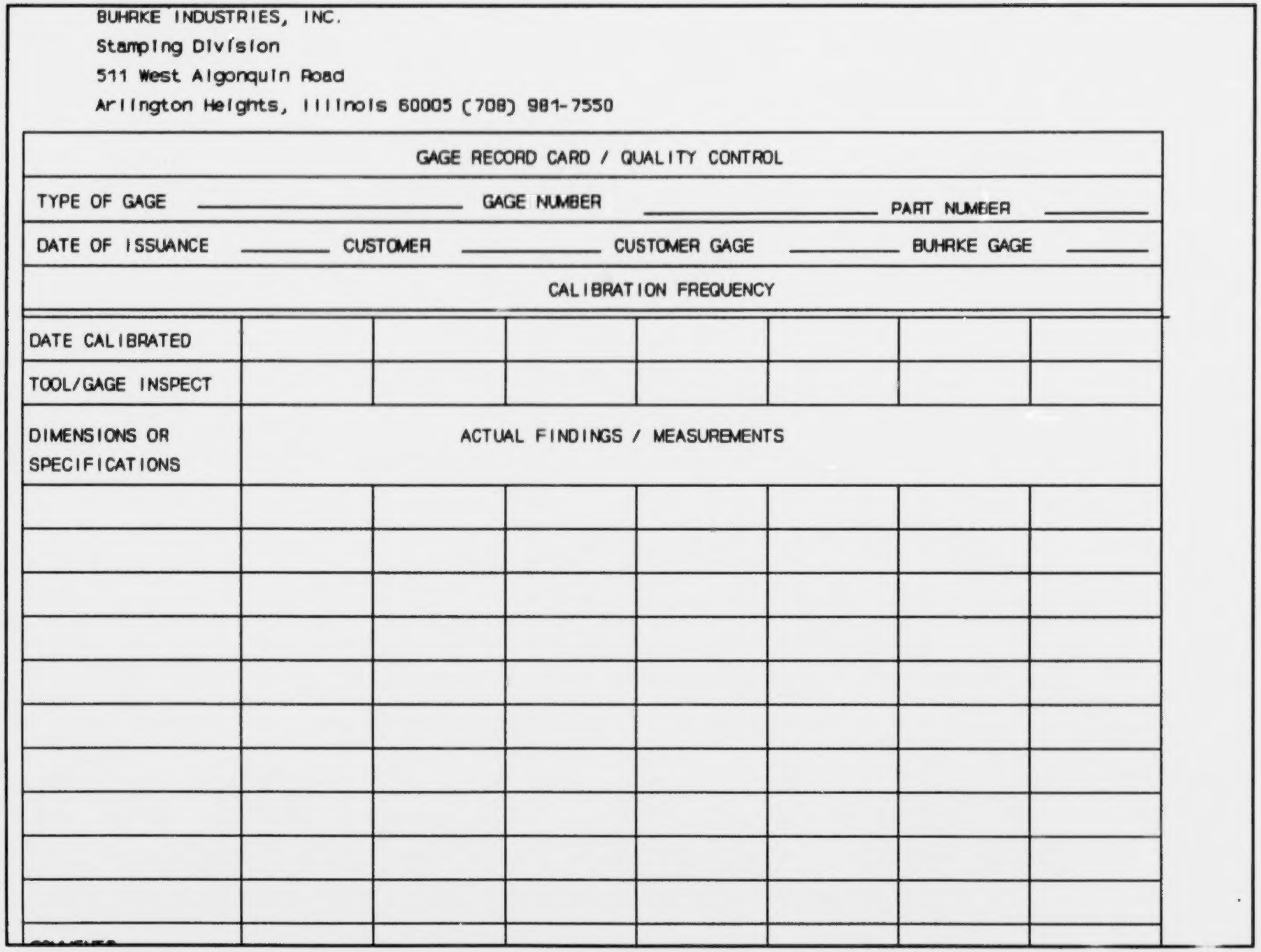
OPERATION NUMBER ________
PAGE ____ OF ____

CUSTOMER ____________ PART NO. ________ REVISION ________ DESCRIPTION ________

STROKES PER MINUTE ____________ JOB NO. ______ QUANTITY ________ CAVITIES/LANES ______

INSPBATERTIMEOPERSETURAGERSONNO.

PPC.011/Fig. 17. Gauge Record Card
(PRODUCT AND PROCESS CONTROL, PPC.011)



BUHRKE INDUSTRIES, INC.
Stamping Division
511 West Algonquin Road
Arlington Heights, Illinois 60005 (708) 981-7550

GAGE RECORD CARD / QUALITY CONTROL

TYPE OF GAGE ____________ GAGE NUMBER ____________ PART NUMBER ________

DATE OF ISSUANCE ________ CUSTOMER ________ CUSTOMER GAGE ________ BUHRKE GAGE ________

CALIBRATION FREQUENCY

DATE CALIBRATED							
TOOL/GAGE INSPECT							
DIMENSIONS OR SPECIFICATIONS	ACTUAL FINDINGS / MEASUREMENTS						

Another method of in-process inspection is **statistical quality control (SQC)**. This type of quality control is a computerized process which is based on random samples taken from the population of the items. The variations in these samples are then plotted on control charts and quality control personnel can determine when parts are nearing tolerance limitations before they reach unacceptable levels. This is a type of preventive measure for control of both product and process. **Statistical process control (SPC)** is a computer analysis of the output of the process and is plotted on charts using the same technique as SQC. Some sample sheets which are used in the SPC process are included in this activity (**see PPC.001/Figs. 18A-J**).

A **time and cost analysis** can also be determined using SPC. These variables can be charted along with other data to determine production efficiency. The **failure mode and effects analysis (FMEA)** (see PPC.011/ Figs. 19A-D) may also be set up using a computerized system. FMEA is generated during the estimating process and is ongoing throughout production. Its purpose is to identify and eliminate potential product-related failure modes or continuously minimize those that cannot be avoided. FMEA may also be used to document the rationale for specific manufacturing processes. **Adaptive control** is another process for controlling process performance. This is a feedback system in which current performance is identified, evaluated and a decision made as to the modification to adapt or make a mechanical change in the operating system.

The final concept of quality control techniques to be discussed is the **quality circle**. This concept was developed by Ishikawa and was first used in Japan where it is called the "quality control circle." The quality circle is a small work group that meets periodically to discuss ways to improve quality. Membership may include a cross section of the manufacturing system. Some companies may have several quality circles within their operation. This type of organization may also improve communication between departments within the system and improve the attitudes of the workers. There is no doubt that a more positive worker attitude will increase efficiency and productivity, and improve the level of awareness of quality control.

The main function of the quality control procedures is to work toward a **zero defects** production system. Increased automation and computerization have greatly increased levels of quality; however, companies must continue to analyze and improve their production systems.

(SPC SAMPLE)

BUHRKE INDUSTRIES, INC.

SUBJECT:

REGARDING:

INTERNAL MEMORANDUM

TO: M. SERNA

FROM:

DATE:

BELOW ARE THE STATISTICAL PROCESS CONTROL INSTRUCTIONS FOR THE SUBJECT PART.

THESE INSTRUCTIONS ARE TO BE FOLLOWED FOR EACH AND EVERY ORDER THAT IS RUN.

ATTACHED ARE THE PROPER FORMS FOR THIS SPC PACKAGE.

SECTION 1

SET-UP CONTROL LIMITS

THE FOLLOWING DIMENSION IS TO RECEIVE THE SET-UP CONTROL LIMITS ANALYSIS FOR FIRST PIECE AND LAST PIECE.

QUALITY CONTROL WILL BE SOLELY RESPONSIBLE FOR THE SET-UP CONTROL PROCEDURES FOR THIS PROJECT.

SECTION II

IN-PROCESS STATISTICAL PROCESS CONTROL

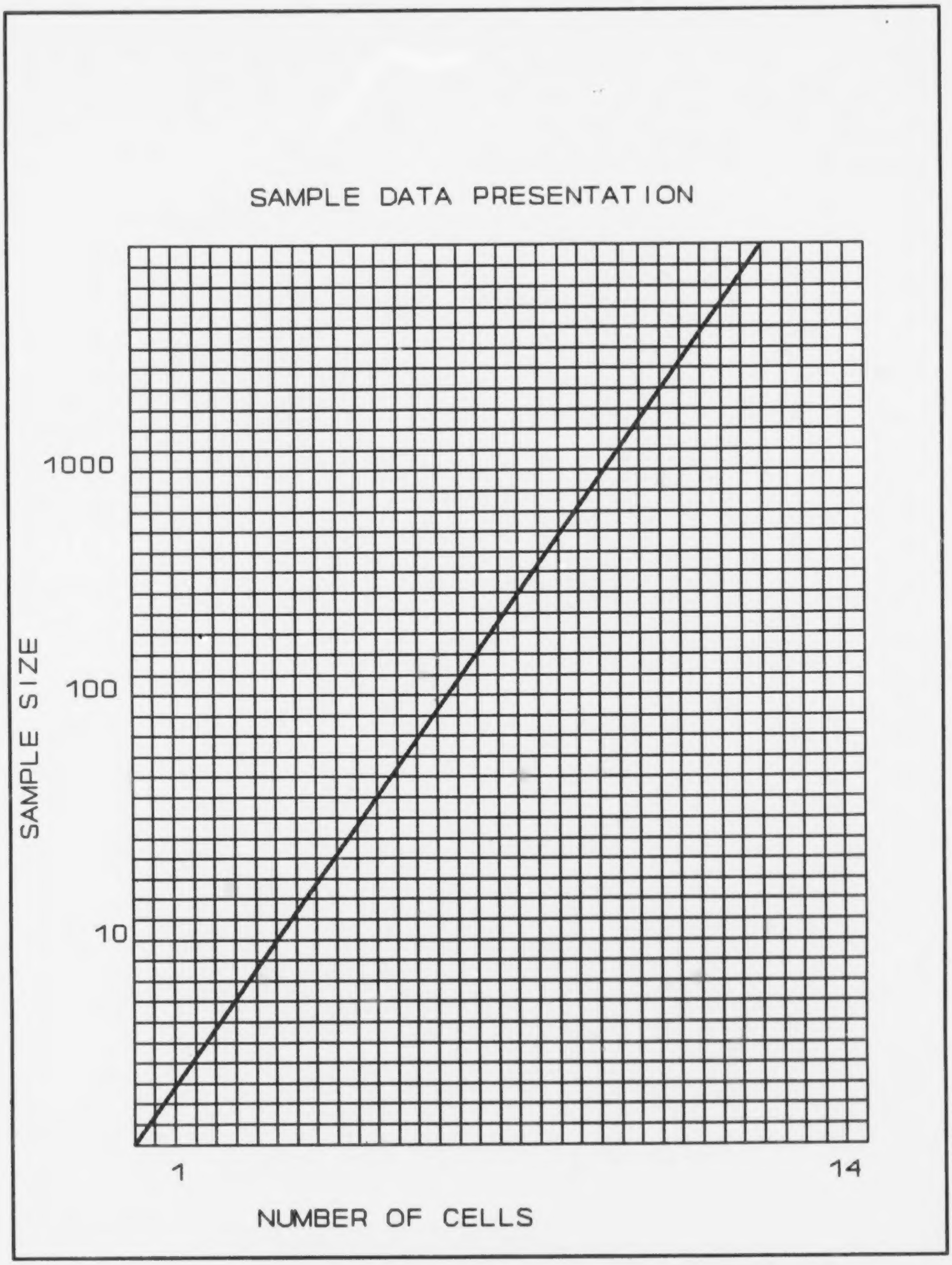
THE DIMENSION LISTED UNDER SECTION I WILL ALSO BE MONITORED STATISTICALLY. THE PRODUCTION OPERATOR WILL BE RESPONSIBLE FOR GENERATING AND EVALUATING THE CHARTS.

SECTION III

IMPLEMENTATION

THESE CONTROL PROCEDURES ARE TO BE IMPLEMENTED IMMEDIATELY.

PPC.011/Fig. 18A. Statistical Process Control Data Sheet
(PRODUCT AND PROCESS CONTROL, PPC.011)



PPC.011/Fig. 18B. Statistical Process Control Data Sheet
(PRODUCT AND PROCESS CONTROL, PPC.011)

STURGES' RULE CONTINUED

EXAMPLE CONTINUED

```
N  21                      x
U  20                      x
M  19                      x
B  18                      x
E  17                      x
R  16                x     x
   15                x     x
O  14                x     x
F  13                x     x     x
   12                x     x     x
O  11                x     x     x
B  10                x     x     x
S   9          x     x     x     x     x
E   8          x     x     x     x     x
R   7          x     x     x     x     x
V   6    x     x     x     x     x     x
A   5    x     x     x     x     x     x     x
T   4    x     x     x     x     x     x     x
I   3    x     x     x     x     x     x     x
O   2    x     x     x     x     x     x     x
N   1    x     x     x     x     x     x     x     x
S   0  ----------------------------------------------

       2.23- 2.29- 2.35- 2.41- 2.47- 2.53- 2.59- 2.65-
       2.28  2.34  2.40  2.41  2.47  2.58  2.64  2.70
```

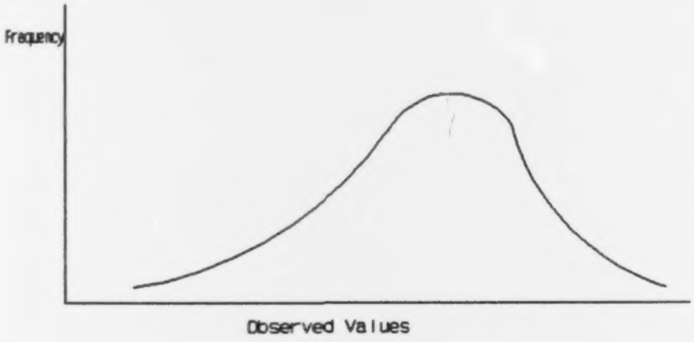
PPC.011/Fig. 18C. Statistical Process Control Data Sheet
(PRODUCT AND PROCESS CONTROL, PPC.011)

THE NORMAL DISTRIBUTION

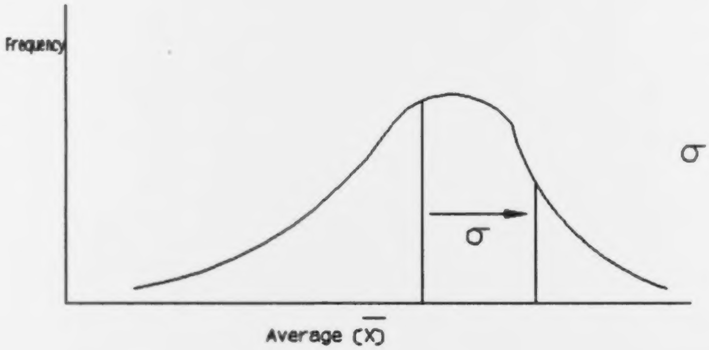
PURPOSE - PROVIDES A MATHEMATICAL APPROACH TO DETERMINE THE X AND OF A DATA SET.

A large variety of engineering and manufacturing data follow a normal distribution. The important characteristics of a normal distribution are:

A normal distribution graphically appears as a symmetrical, bell-shaped curve:

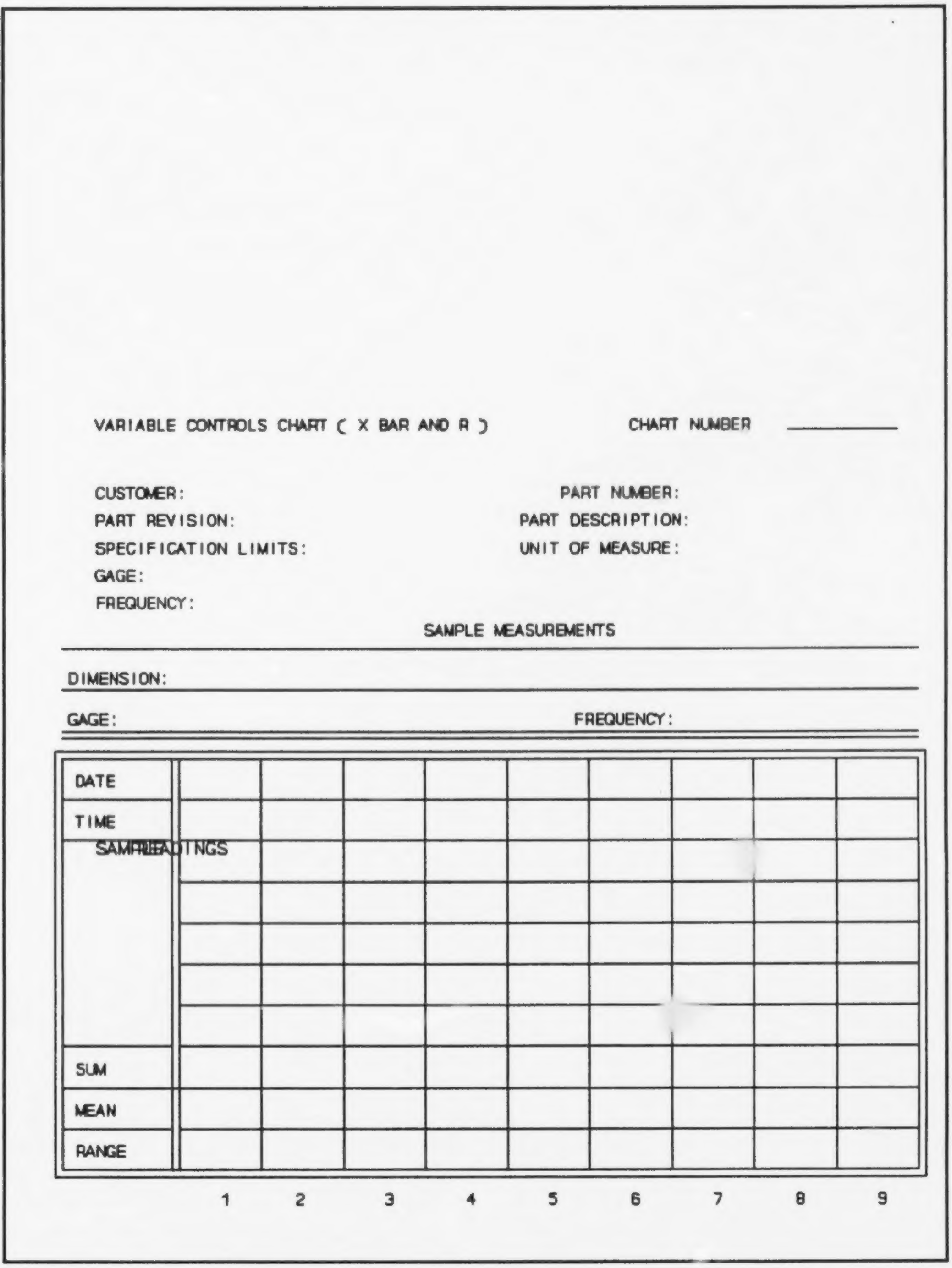


A normal distribution is completely described by two characteristics: Average (or mean) and standard deviation:



σ (Sigma) = Standard Deviation

PPC.011/Fig. 18D. Statistical Process Control Data Sheet (PRODUCT AND PROCESS CONTROL, PPC.011)



VARIABLE CONTROLS CHART (X BAR AND R)   CHART NUMBER ________

CUSTOMER: PART NUMBER:

PART REVISION: PART DESCRIPTION:

SPECIFICATION LIMITS: UNIT OF MEASURE:

GAGE:

FREQUENCY:

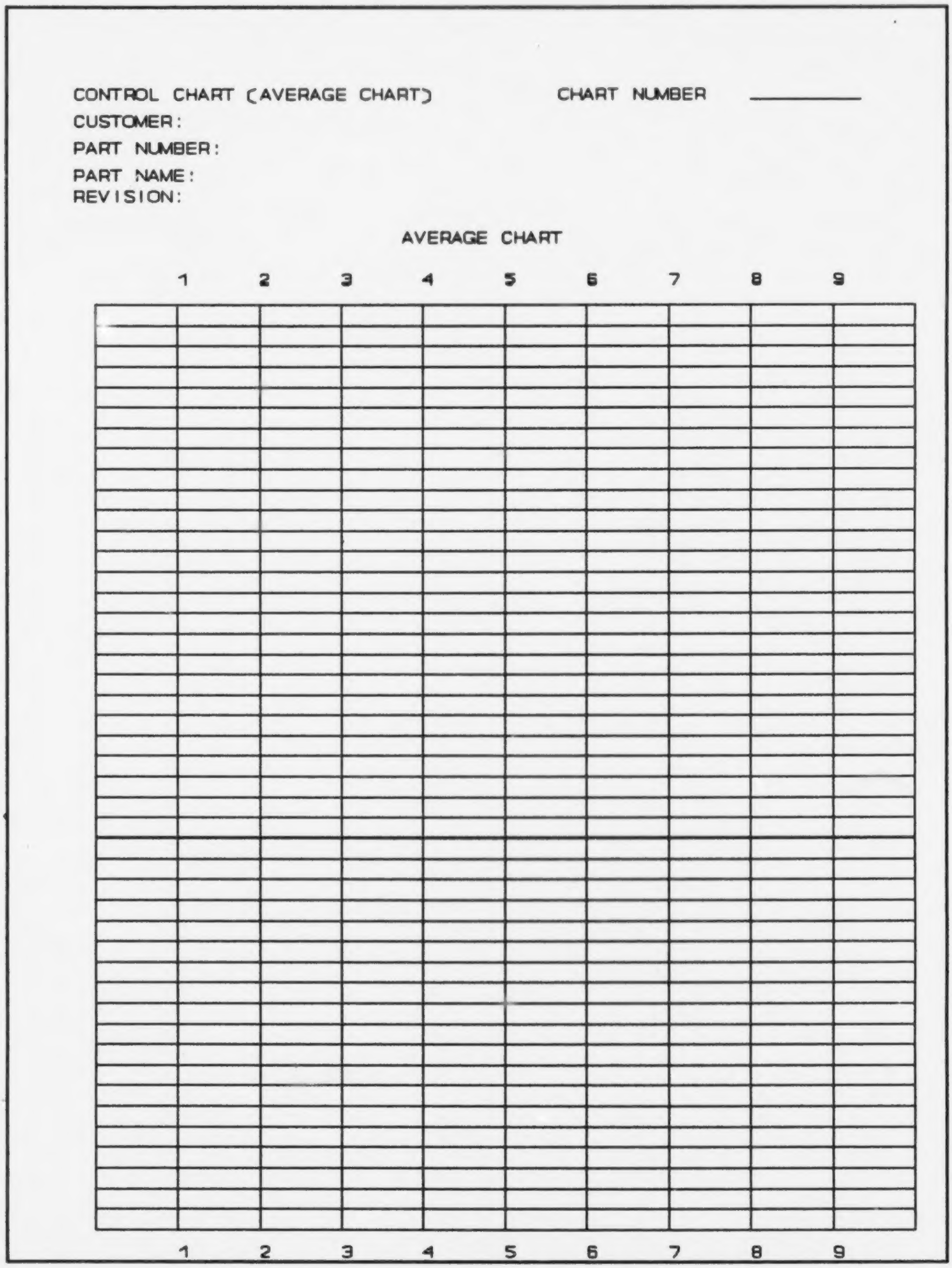
SAMPLE MEASUREMENTS

DIMENSION:

GAGE: FREQUENCY:

DATE									
TIME									
SAMPLE READINGS									
SUM									
MEAN									
RANGE									
	1	2	3	4	5	6	7	8	9

PPC.011/Fig. 18E. Statistical Process Control Data Sheet (PRODUCT AND PROCESS CONTROL, PPC.011)



CONTROL CHART (AVERAGE CHART) CHART NUMBER ________

CUSTOMER:

PART NUMBER:

PART NAME:

REVISION:

AVERAGE CHART

1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
7
8
9

PPC.011/Fig. 18F. Statistical Process Control Data Sheet (PRODUCT AND PROCESS CONTROL, PPC.011)

CONTROL CHART (RANGE CHART) CHART NUMBER ____________

CUSTOMER:

PART NUMBER:

PART NAME:

REVISION:

RANGE CHART

	1	2	3	4	5	6	7	8	9
	1	2	3	4	5	6	7	8	9

NOTES

PPC.011/Fig. 18G. Statistical Process Control Data Sheet
(PRODUCT AND PROCESS CONTROL, PPC.011)

CALCULATION WORK SHEET

$\bar{R}$ = ER/k = ______________________________ = ______________________________

X DOUBLE BAR = E$\bar{X}$/k = ________________________ = ________________________

X' (MIDSPEC. OR STD.) = ______________________________

$A_2\bar{R}$ = ______________________ X ________________________ = ____________________

$UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R} =$ ______________ + ______________ = ____________________

$LCL_{\bar{X}} = \bar{\bar{X}} - A_2\bar{R} =$ ______________ - ______________ = ____________________

$UCL_R = D_4\bar{R} =$ ____________________ X ______________ = ____________________

FACTORS FOR CONTROL LIMITS

n	A_2	D_4	d_2	$3/d_2$	A_m
2	1.880	3.268	1.128	2.259	0.779
2	1.023	2.574	2.693	1.772	0.749
4	0.729	2.282	2.059	1.457	0.728
5	0.577	2.114	2.326	1.290	0.713
6	0.483	2.004	2.534	1.184	0.701

PPC.011/Fig. 18H. Statistical Process Control Data Sheet
(PRODUCT AND PROCESS CONTROL, PPC.011)

STATISTICAL PROCESS CONTROL
CORRECTIVE ACTION LOG SHEET

ANY CHANGE IN PEOPLE, MATERIALS, ENVIRONMENT, METHODS, OR MACHINES SHOULD BE NOTED. THESE NOTES WILL HELP YOU TAKE CORRECTIVE ACTION WHEN SIGNALED BY THE CONTROL CHART.

DATE	ENTRY	OPERATOR	PROBLEM	CORRECTIVE ACTION

PPC.011/Fig. 18I. Statistical Process Control Data Sheet (PRODUCT AND PROCESS CONTROL, PPC.011)

LOG SHEET

RECORD ALL SHIM CHANGES TO ACHIEVE PROPER ADJUSTMENTS. THIS LOG SHEET WILL BE MAINTAINED BY A-R AND THE QUALITY CONTROL DEPARTMENT AND THIS RECORD WILL REMAIN ON RECORD IN THE QUALITY CONTROL DEPARTMENT.

	EMPLOYEE	DATE	MATERIAL TH.	SHIMS TOP		SHIMS TOP	
				X	Y	X	Y
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							

PPC.011/Fig. 18J. Statistical Process Control Data Sheet
(PRODUCT AND PROCESS CONTROL, PPC.011)

FMEA INSTRUCTIONS

1. DIMENSION OR CHARACTERISTIC

   SPECIFY THE DIMENSION OR CHARACTERISTIC BEING ANALYZED.

2. POTENTIAL FAILURE

   DESCRIBE EACH POSSIBLE FAILURE MODE. THE ASSUMPTION IS MADE THAT THE FAILURE COULD OCCUR, BUT WILL NOT NECESSARILY OCCUR. THE PEOPLE WORKING ON THE FMEA SHOULD BE ABLE TO ANSWER THE QUESTIONS, "WHAT CAN POSSIBLY GO WRONG WITH THE PROCESS?" AND "HOW CAN THE PART FAIL TO MEET CUSTOMER SPECIFICATIONS?" A REVIEW OF THE PAST DESIGN FMEA'S OR QUALITY PROBLEMS ON COMPARABLE COMPONENTS IS A GOOD STARTING POINT.

3. POTENTIAL EFFECT(S) OF FAILURE

   ASSUMING THE FAILURE HAS OCCURRED, DESCRIBE WHAT MIGHT BE EXPERIENCED BY THE CUSTOMER: "WHAT WILL RESULT FROM THE FAILURE MODE IDENTIFIED?" THE DESCRIPTION MUST BE AS SPECIFIC AS POSSIBLE.

4. RECOMMENDED ACTION

   THE NEED FOR TAKING SPECIFIC, POSITIVE CORRECTIVE ACTION WITH QUANTIFIABLE BENEFITS, RECOMMENDED ACTION TO OTHER ACTIVITIES, AND FOLLOW-UP OF ALL RECOMMENDATIONS CANNOT BE OVEREMPHASIZED. A THOROUGHLY THOUGHT-OUT AND WELL-DEVELOPED PROCESS FMEA WILL BE OF LIMITED VALUE WITHOUT POSITIVE AND EFFECTIVE CORRECTIVE ACTIONS. IT IS THE RESPONSIBILITY OF ALL AFFECTED ACTIVITIES TO IMPLEMENT EFFECTIVE FOLLOW-UP PROGRAMS TO ADDRESS ALL RECOMMENDATIONS.

5. OCCURRENCE RANKING

   ESTIMATE THE PROBABILITY OF OCCURRENCE ON A SCALE OF 1 THROUGH 10 AS DEFINED BELOW.

PPC.011/Fig. 19A. Failure Mode and Effects Analysis Data Sheet
(PROCESS AND PRODUCT CONTROL, PPC.011)

CRITERIA	RANKING
REMOTE PROBABILITY OF OCCURRENCE.	1 2
LOW PROBABILITY OF OCCURRENCE. PROCESS IN STATISTICAL CONTROL.	3 4
MODERATE PROBABILITY OF OCCURRENCE. GENERALLY ASSOCIATED WITH PROCESSES SIMILAR TO PREVIOUS PROCESSES WHICH HAVE EXPERIENCED OCCASIONAL FAILURES, BUT NOT IN MAJOR PROPORTIONS. PROCESSES THAT HAVE OFTEN FAILED.	5 6
HIGH PROBABILITY OF OCCURRENCE. GENERALLY ASSOCIATED WITH PROCESSES SIMILAR TO PREVIOUS PROCESSES THAT HAVE FAILED.	7 8
VERY HIGH PROBABILITY OF OCCURRENCE. IN EVALUATOR'S VIEW, FAILURE IS ALMOST CERTAIN TO OCCUR.	9 10

DIMENSIONS OR CHARACTERISTICS RECEIVING A HIGH OCCURRENCE RANKING SHOULD BE GIVEN SPECIAL ATTENTION AND APPROPRIATE CORRECTIVE ACTION TO REDUCE THE RANKING.

6. SEVERITY

SEVERITY IS THE ACTION THAT REPRESENTS THE SERIOUSNESS OF THE FAILURE TO THE CUSTOMER AFTER IT HAS OCCURRED. ESTIMATE THE SEVERITY OF THE "EFFECTS OF FAILURE" ON A SCALE OF 1 THROUGH 10 AS DEFINED BELOW.

THE SEVERITY RANKING, WITH RESPECT TO THE CUSTOMER, CAN ONLY BE CHANGED BY DESIGN ACTIONS. IT IS NOT AFFECTED BY MANUFACTURING OR PROCESS CONTROLS. SINCE THE SEVERITY IS SOLELY BASED ON THE EFFECT OF FAILURE, ALL POTENTIAL CAUSES OF FAILURE FOR A PARTICULAR EFFECT OF FAILURE WOULD RECEIVE THE SAME SEVERITY RANKING. REFER TO THE CUSTOMER FOR RECOMMENDED SEVERITY RANKINGS OR ESTIMATE THE SEVERITY RANKING IF THE CUSTOMER INFORMATION IS NOT AVAILABLE.

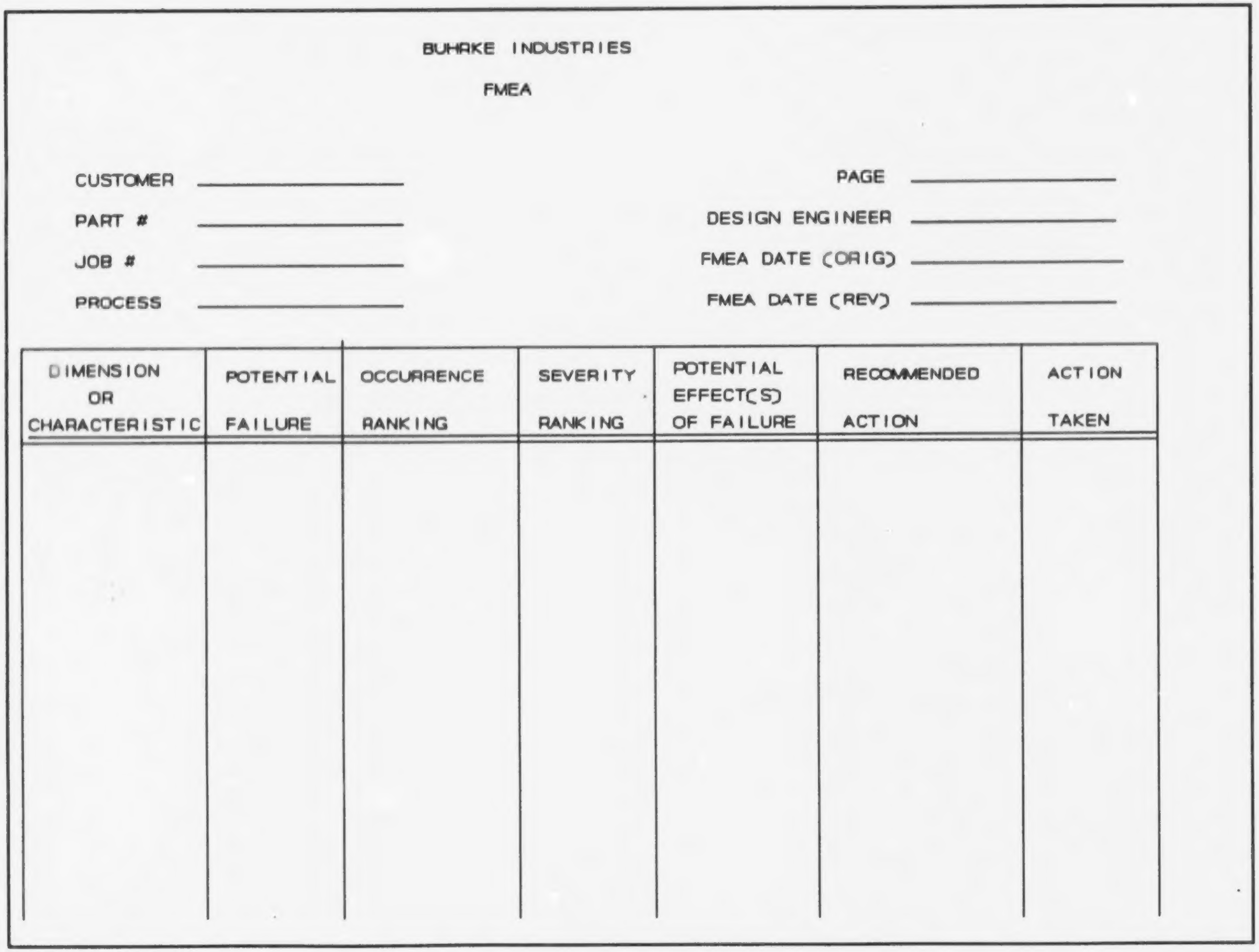
PPC.011/Fig. 19B. Failure Mode and Effects Analysis Data Sheet
(PROCESS AND PRODUCT CONTROL, PPC.011)

SEVERITY RANKING

CRITERIA	RANKING
UNREASONABLE TO EXPECT THAT THE MINOR NATURE OF THIS FAILURE WOULD CAUSE ANY NOTICEABLE EFFECT ON THE END PRODUCT.	1
LOW SEVERITY RATING DUE TO MINOR NATURE OF FAILURE CAUSING ONLY A SLIGHT CUSTOMER ANNOYANCE.	2 3
MODERATE FAILURE WHICH CAUSES SOME CUSTOMER DISSATISFACTION, CUSTOMER IS ANNOYED BY THE FAILURE. FOR EXAMPLE, THE PART WILL NOT FIT INTO THE MATING PART OR SUBSYSTEM WITHOUT SOME DEGREE OF DIFFICULTY.	4 5 6
HIGH DEGREE OF CUSTOMER DISSATISFACTION DUE TO THE NATURE OF THE FAILURE SUCH AS THE PART CANNOT BE SORTED, REWORKED, ETC., OR FAILURE WHICH CAUSES THE END PRODUCT TO DEGRADE IN AREAS GOVERNED BY FEDERAL REGULATIONS BUT DOES NOT INVOLVE VEHICLE SAFETY OR NON-COMPLIANCE TO FEDERAL OR STATE LAW.	7 8
VERY HIGH SEVERITY RANKING, WHEN A FAILURE MODE INVOLVES POTENTIAL SAFETY PROBLEMS AND/OR CONFORMANCE TO FEDERAL REGULATIONS. IN GENERAL, NON-REGULATED PARTS RECEIVING A 9 OR 10 SEVERITY RANKING WITH OCCURRENCE RANKINGS GREATER THAN 1 WILL BE DESIGNATED BY THE CUSTOMER'S PRODUCT ENGINEERING AS A CONTROL ITEM.	

PPC.011/Fig. 19C. Failure Mode and Effects Analysis Data Sheet
(PROCESS AND PRODUCT CONTROL, PPC.011)

PPC.011/Fig. 19D. Failure Mode and Effects Analysis Data Sheet
(PROCESS AND PRODUCT CONTROL, PPC.011)



BUHRKE INDUSTRIES

FMEA

CUSTOMER ______________

PART # ______________

JOB # ______________

PROCESS ______________

PAGE ______________

DESIGN ENGINEER ______________

FMEA DATE (ORIG) ______________

FMEA DATE (REV) ______________

DIMENSION OR CHARACTERISTIC	POTENTIAL FAILURE	OCCURRENCE RANKING	SEVERITY RANKING	POTENTIAL EFFECT(S) OF FAILURE	RECOMMENDED ACTION	ACTION TAKEN

Student Activity Sheet Number: PPC.011

This is an exercise designed to give students experience in designing a quality control procedure to be used for a product. They will also need to identify some of the types of quality checks to be performed and recommend some tools and equipment which might be appropriate for this procedure.

The students will be divided into four teams as follows:

1. Design engineers
2. Quality control personnel
3. Production supervisors
4. Machine technicians or operators

Each team will be asked to develop a list of quality control procedures for a given product. The teams will identify the responsibilities of their areas for quality measures to be used. They will also list any of the tools or equipment to be used to assist in quality control in their area. Remember to consider the quality control of the process as well as the product.

Each team will present its procedures to the entire group. The instructor will act as vice president of operations to guide the group activity. All teams will discuss their completed plans.

Alternative Strategies for Activity Number: PPC.011

Students will research various types of quality control procedures and theories by prominent individuals. They will write a report on the different methods used to maintain quality control standards and explain the concepts. They will also discuss the origins of the various quality control techniques and equipment used in manufacturing today.

Learning Check Sheet: PPC.011

Complete the following:

1. ____________________ is the procedure taken to remedy the source of the problem causing a defect.

2. List the three stages of work-in-process and define each.

   A.

   B.

   C.

3. The checking, adjustment, and replacement of worn parts on machines to keep them from breaking down is known as_______________________.

4. A condition by which effective parts are caused by equipment inaccuracies is known as __________________.

5. The number of times that a part must be checked for accuracy is known as ______________________________.

6. The inspection of parts while they are being produced is known as ___________________________________.

7. Name five types of inspection methods and name one example of a tool in each one.

	Inspection Method	Tool Name
A.		
B.		
C.		
D.		
E.		

8. ________________________ uses a computer and plotted information on a chart to control the quality of a product.

9. A quality control procedure set up during the estimating process is known as ____.

10. A concept developed in Japan in which a group of company personnel gather to discuss ways to improve quality is ____________________.

Discuss the following:

1. Explain the importance of product and process quality control.

2. Discuss some of the procedures used to minimize product defects.

Learning Check Answer Key: PPC.011

1. Corrective action
2. A. Rejects
   B. Rework
   C. Accepted work
3. Preventive maintenance
4. Machine error
5. Frequency of inspection
6. In-process inspection
7.

A. Visual	Surface finish
B. Gauging	Plug gauge
C. Measurement Tool	Micrometer
D. Sensor	Coordinate Measuring Machine
E. Optical	Vision system

8. Statistical quality control
9. Failure mode and effects analysis
10. Quality circle

Performance Check: PPC.011

The instructor will evaluate the teams' performance in developing a quality control procedure and a list of tools and checks to be made. They will also be evaluated on their presentation of information. Each individual student will be evaluated on his/her input into the process. Individual students will also be evaluated on test performance.

ACTIVITY NUMBER PPC.012

COMPUTER CONTROLLED APPLICATIONS

Description:

Automation in manufacturing is rapidly changing the way parts and products are manufactured. The use of computer controlled machines has increased the level of output and efficiency of operations. Students should be aware of the various computer controlled processes used to manufacture products and have an understanding of how they affect the control of a production system. In this exercise, the students will be introduced to the operation of computer controlled machines. They will develop an understanding of their advantages over conventional machines. The students will gain some experience in the programming, setup, and operation of a CNC machine.

Rationale:

The use of a variety of different types of automated processes in industry is rising rapidly. Computer controlled applications are used not only for the control of equipment, but also for control of the manufacturing process. Students should be aware of the kinds of technology being used in industry today. They should also have an understanding of the operating principles of computer controlled equipment.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of the use of automated machines in industry.
2. Identify some of the types of automated equipment used for production processes.
3. Discuss some of the applications of automated systems control in a manufacturing operation.
4. Produce a part on a conventional machine; then develop a program, set up, and operate a CNC machine to produce the same part.
5. Compare the advantages and disadvantages of the two operations.

Tools, Materials, Machines and Resources:

1. Groover, M. P. (1980). Automation, production systems, and computer-aided manufacturing. Englewood Cliffs, NJ: Prentice-Hall, Inc.
2. White, J. A. (1987). Production handbook (4th ed.). New York: John Wiley & Sons.
3. Wright, T. R. (1987). Processes of manufacturing. South Holland, IL: Goodheart-Willcox Company, Inc.
4. Automation--What is it? (film). New York: National Association of Manufacturers.
5. Modern corporations (film). Los Angeles, CA: Sutherland Educational Films, Inc.
6. Mastercam CNC programming (IBM). (1989). Tolland, CT: CNC Software Inc.
7. Spectracam (IBM/Apple). (1988). Manchester, NH: Light Machines Corporation.
8. Graph paper, part drawing, programming information, CNC machine.

Instructional Strategies:

The instructor will discuss the applications of automated systems in manufacturing operations. A film or video may be used to show industrial applications of controlled processes. The instructor will show CNC programming techniques and demonstrate the setup and operation of a conventional machine and a CNC machine for making a part. The students will then complete a part on each machine and compare the results.

Safe Practices:

Follow the required safety rules for setup and operation of both machines and tools. The students will be given a safety test on both machines so that they are aware of safe operating procedures.

Integrative Skills

Communication:

☒ Reading
☒ Writing
☒ Speaking
☒ Listening

Computation:

☒ Fractions
☒ Decimals
☐ Percents

Personal

Teamwork (Interpersonal):

☒ Assertiveness
☒ Negotiation
☒ Listening
☒ Risk Taking

Change:

☒ Personal Adaption
☐ Professional Adaption

Computer:

☒ Operating Systems
☒ Keyboards
☒ Applications ____________________

Decision Making:

☒ Ethical Reasoning
☒ Logical Reasoning
☒ Flexibility

Problem Analysis:

☒ Identification
☒ Solutions
☒ Evaluation
☐ Implementation

The use of automated processes in manufacturing is advancing at a rapid pace. A variety of different operations can be adapted to a computer controlled system. The term **automation** was coined by Delmar Harder of Ford Motor Company shortly after World War II. Automation is generally defined as automatically controlled manufacture. Computers and controllers are interfaced with production operations to increase the level of output. Automation is not only used to control the operations of individual machines, but also to control the processes of the entire manufacturing operation. **Logic control (LC)** was initially used to control operations. The logic control units operated by means of sending impulse signals which would turn switches on and off. The logic controllers, however, had no means of storing information in memory or could not analyze any previous information. The addition of a computer to the system greatly increased its capabilities. The programmable logic control (PLC) system could store and analyze information and is used to control a variety of operations.

Not all equipment is readily adaptable to computer controls. There are several production variables which may affect the use of computer controlled applications. Many of the older machines were expensive to convert or might not even be able to be converted at all. The **machine design** is one factor in the consideration of an automated process. Most of the newer equipment can be set up with computer controlled applications, which will increase the effectiveness of the operation. The **type of product** is also a determining factor. Automated systems can sometimes produce parts which cannot be manufactured any other way. Some products may not be adaptable to a computer controlled process and may be less economical to produce. The **cost effectiveness and efficiency** of the automated system usually far exceeds the conventional method. The level of output is usually increased along with the accuracy of finished parts.

The earlier machines were operated by a system known as **numerical control (NC)**. This type of machine was commonly operated by punched tapes which controlled the machine operations. They were somewhat limited in their storage and retrieval capabilities. The newer **computer numerical control (CNC)** machines allowed much more flexibility in machining operations. The machines could be operated from information programmed on the computer and the information stored for future use. The use of **direct numerical control (DNC)** allowed for large-scale control of production operations. The DNC could be used to control a number of CNC machines. Both systems could be used for programming information to produce parts using a machine language and sent directly to the machine to complete the operation. The CAD/CAM link allowed for still greater flexibility. The **CAD or computer aided design** system can be used to design parts and produce detailed drawings on the computer. The CAM is a **computer automated manufacturing (CAM)** system which can be used to control a series of production operations. By linking the two together, additional speed and efficiency were integrated into the system. Products could be designed on the computer and software used to convert the information into the machine language automatically. The part could then be produced immediately. This level of control has significantly reduced the lag time from the design stage of a product to the finished part.

The addition of the automated applications not only increased production levels and accuracies of finished parts, but also brought about a higher level of control of the entire operation. Feedback systems could be used to troubleshoot potential problems and provide for closer process control in the manufacturing operation. Greater accuracies in machining operations also provided closer product control and higher levels of quality control. The automated systems have definite advantages over conventional processes. Even though the initial cost and maintenance are higher, they are offset by the increased level of productivity and profit.

Student Activity Sheet: PPC.012

This exercise will be used to introduce the students to the advantages of automated machining processes. The student will learn that computer controlled operations provide for a much higher level of process and product control by increasing speed, accuracy, and versatility. The students will work in teams of 2 to 3 members. The instructor will supply each team with a part drawing and instructions for developing a program for the type of CNC machine in his/her lab facility. The instructor will also give the students a complete demonstration on the machine safety procedures as well as the setup and operation of the equipment. The students will also be given a demonstration on the conventional equipment to be used for the production of the part.

The students will use the following procedure to complete their part:

1. Study the drawing and determine the best way to set up and make the part on a conventional machine.
2. Develop a process plan for machining the part.
3. Set up and machine the part.
4. Keep track of the time it takes to set up and machine the part.
5. Check the accuracy of the finished part and record tolerance variations.
6. Using the same drawing, write a program to machine the part on the CNC machine. Use graph paper to plot out the machine movements. If available, CNC programming software may be used in a computer lab to complete this activity.
7. Each team will then load its programs onto the CNC machine controller.
8. Keep track of the time it takes to set up the CNC machine, load the program, and machine the part.
9. Set up and machine the part on the CNC.
10. Check the accuracy of the finished part and record tolerance variations.
11. Compare the results of the two processes.
12. Be prepared to discuss the results with the other groups with reasons for the differences.

The group will then discuss the results of the two methods of production. Consider this on a larger scale as used in a manufacturing system.

If a CAD/CAM system is available, the instructor may want to demonstrate the use of the CNC software to take a part designed on the CAD system, interface it with the CAM and load the information directly onto the CNC machine to make the part. The students can then discuss the time factors involved in designing a part, writing a program, and doing the actual machining.

Alternative Strategy for Activity Number PPC.012

The students will visit a local manufacturing company. They will note the types of automated systems used in the company. They will observe the processes used to design parts, program them, and complete the machining operations. The students will prepare a report on the various types of automated systems observed and explain their applications in the manufacturing system. They will also discuss the advantages and disadvantages of the automated system.

The reports can be presented to the group for discussion.

Learning Check Sheet: PPC.012

Match the following:

__1. PLC

__2. DNC

__3. CAM

__4. CNC

__5. LC

__6. NC

A. Operations control unit that has no memory storage capabilities.

B. Automated machines operated by punched tapes.

C. An automated system used to control a series of manufacturing operations.

D. Operations control unit that can store and analyze information.

E. Capable of controlling operations directly from a computer.

F. Machine operated by a program developed on a computer.

Discuss the following:

1. Explain the importance of the use of automated machines in industry.

2. Discuss some of the applications of automated systems control in a manufacturing operation.

Learning Check Answer Key: PPC.012

1. D

2. E

3. C

4. F

5. A

6. B

Performance Check: PPC.012

The instructor will evaluate the team's development of the process sheet for machining the part on a conventional machine. The teams will also be evaluated on the setup and operation of the machine, as well as on their development of the CNC program and the CNC machine operation to complete the part. The presentation of their analysis of the two processes will also be evaluated. Each student will be evaluated on test performance.

ACTIVITY NUMBER PPC.013

AUTOMATED MANUFACTURING SYSTEMS

Description:

Automated systems may be used to operate an entire manufacturing process. These applications can be used to increase the efficiency of producing a product. In this activity, the use of computerized systems to operate a series of machines or processes will be discussed. The students will have an opportunity to design and operate a small-scale automated system consisting of a series of operations. This will help then to develop an awareness of how multiple manufacturing operations are designed.

Rationale:

Many of our manufacturing systems are designed for a series of computerized applications. Some are set up as work cells or fully integrated systems. Both product and process can be monitored more closely with these systems.It is important that students have an understanding of some of the large-scale applications of automation.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of integrated manufacturing systems.
2. Identify several types of integrated manufacturing systems.
3. Discuss the ways in which factory automation increases the level of product and process control.
4. Demonstrate the operation of a robotic work cell.

Tools, Materials, Machines and Resources:

1. Groover, M. P. (1980). Automation, production systems, and computer-aided manufacturing. Englewood Cliffs, NJ: Prentice-Hall, Inc.
2. Wright, T. R. (1987). Processes of manufacturing. South Holland, IL: Goodheart-Willcox Company, Inc.
3. Factory of the future (video). (1989). Garden City, NY: Bergwall Productions.
4. Robot assembly lab (Apple computer program). (1988). Westerville, OH: Kitchen Sink Software, Inc.
5. Scorbot robot programming (IBM/Apple). (1987). Morse, IL: Aidex Corporation.
6. Graph paper, programmable robot, work cell stations, and materials.

Instructional Strategies:

The instructor will discuss automated manufacturing and integrated systems, and the use of robots in work cell environments. The students will work in teams to develop a work cell application using a programmable robot. They will also develop a program for a work cell process.

Safe Practices:

Follow the required rules for the operation and handling of CNC robots. Use care with computer operations.

Integrative Skills

Communication:

- ☒ Reading
- ☒ Writing
- ☒ Speaking
- ☒ Listening

Computation:

- ☒ Fractions
- ☒ Decimals
- ☐ Percents

Personal

Teamwork (Interpersonal):

- ☒ Assertiveness
- ☒ Negotiation
- ☒ Listening
- ☒ Risk Taking

Change:

- ☒ Personal Adaption
- ☒ Professional Adaption

Computer:

- ☒ Operating Systems
- ☒ Keyboards
- ☒ Applications ______________________________

Decision Making:

- ☒ Ethical Reasoning
- ☒ Logical Reasoning
- ☒ Flexibility

Problem Analysis:

- ☒ Identification
- ☒ Solutions
- ☒ Evaluation
- ☒ Implementation

Automation is a term that may be used to describe a single machining operation or represent an entire integrated manufacturing system. In this unit, automation will be discussed in terms of a series of operations linked together in a manufacturing system. An automated system might be defined as the application of mechanical, electronic, and computer-based systems to operate and control production. There are various types of automation. These might be classified as **fixed automation, programmable automation, and flexible automation.**

Fixed automation is a system in which the sequence of processing operations is fixed by the equipment configuration. The operations are usually simple and many of them must be coordinated into one piece of equipment. The characteristics of this type of system are that it usually requires a high initial investment, high production rates, and is relatively inflexible in accommodating product changes. An example of this might be an assembly line.

Programmable automation is a system in which the production equipment is designed with the capability to change the sequence of operations to accommodate different product configurations. The operation of this is controlled by a computer program of coded instructions. The characteristics of this type of system are that it usually requires a high investment, has low production rates, is good for batch production and is flexible to handle changes in products. A numerically controlled machine tool or robot would be examples of this type of application. These are set up for short operations, then must be reprogrammed and retooled for another product.

Flexible automation is an extension of programmable automation. This is a more recent concept developed in the last 15 to 20 years. This system is capable of producing a variety of products with very little lost time in making changeovers from one product to the next, or during reprogramming. The features of this system would be a high initial cost, continuous production of a variety of products, medium production rates, and flexibility for product changes. The changeover capability of this type of system with little lost time makes it different from programmable automation.

This type of flexibility has brought about the development of advanced production automation technologies. One such system is known as **computer integrated manufacturing (CIM).** This system involves the use of computers to design the product, plan the production, control the operations, and perform the various business-related functions needed in a manufacturing firm. CIM provides for a high level of product and process control in a production operation. Computer feedback loops provides information for preventive maintenance and quality control limitations. This type of system will offer many applications for the total computer-automated factories of the future.

A **flexible manufacturing system (FMS)** may be a part of CIM system. The FMS system consists of a group of processing stations interconnected by means of an automated material handling and storage system, and controlled by an integrated computer system. The FMS system is capable of processing a variety of different types of parts simultaneously using computer program control at various work stations. If the FMS process is designed so that a group of several machines are served by a robot, it is called a **flexible manufacturing cell.** This type of cell is more highly automated than a single machine cell or a group machine cell. These are commonly referred to as **work cells,** and are usually served by some type of robot arm. These types of operations usually have automatic machine control, automatic tool changing and automatic material handling.

Automated systems have a number of advantages over standard operations. The automated system usually increases productivity, eliminates some of the high manual labor costs, compensates for labor shortages, offers a higher level of safety, provides improved product quality, reduces manufacturing lead time, reduces in-process inventory, uses materials more efficiently thus reducing scrap; and affords higher machine utilization, greater flexibility in production scheduling, and gives the manufacturer a competitive edge in the business market.

Product and process control is greatly increased when using automated systems. Materials, cycle times, and rates can be manipulated through the computer system. Information feedback is another important aspect of this system. The increased level of communication throughout the production process greatly improves the efficiency of the overall manufacturing operation.

Student Activity Sheet: PPC.013

In this exercise, the students will design a manufacturing work cell. The cell will consist primarily of a programmable robot which will be set up to perform several different operations at various stations. The robot will be programmed to do several "pick-and-place" operations If available, one or more CNC machines may be integrated into the work cell operation. The students will form teams of 3 to 5 members and develop a program for robot activity. They will then set up the stations within the work cell and position the materials to be handled.

The teams will then operate their work cell and evaluate the set up and accuracy of operation. The teams may compete against each other by developing one work cell configuration and attempting to program the most accurate completion of the assigned work cell tasks.

The teams will then analyze and discuss the applications of work cells in manufacturing and the advantages and disadvantages of integrated and flexible manufacturing systems.

Alternative Strategy for Activity Number: PPC.013

If the lab is not equipped with CNC equipment, the students can work in teams to build a manual work cell. Simple mechanical robot arms can be constructed of wood, metal or plastic and operated manually. A work cell simulation can be achieved. Relatively inexpensive remote control battery-operated robots can be purchased to use in the activity as well.

Learning Check Sheet: PPC.013

Complete the following:

1. A type of system in which the sequence of processing operations is determined by the equipment configuration is called _________________________.

2. A _________________________________ is a type of system in which all the operations are computer controlled including planning and control functions.

3. A group of machines served by a robot is called a __________________.

4. A system capable of producing a variety of products with little lost time in changeover is known as ________________________.

5. ___________________________ is a type of system in which the production equipment is designed with the capability to change the sequence of operations to accommodate different product configurations.

Discuss the following:

1. Explain the importance of integrated manufacturing systems.

2. Discuss the ways in which factory automation increases the level of product and process control.

Learning Check Answer Key: PPC.013

1. Fixed automation
2. Computer integrated manufacturing (CIM)
3. Work cell
4. Flexible automation
5. Programmable automation

Performance Check: PPC.013

The instructor will evaluate each team's work cell setup and the program for operation. The efficiency and accuracy of operation of the work cell will also be given consideration. Each student will be evaluated on test performance.

ACTIVITY NUMBER PPC.014

PRODUCT IDENTIFICATION, PACKAGING, AND STORAGE

Description:

Manufactured goods may either be stored or shipped after the production processes have been completed. In this activity, the techniques used for the packaging and storage of finished goods will be evaluated. Students should be aware of the importance of protective packaging to protect finished goods until they reach the customer. They should also be able to describe some of the methods used to identify goods which are placed in storage and the procedures used to retrieve these goods. In this exercise, the students will determine the methods used to identify, store, and retrieve finished goods in a manufacturing system.

Rationale:

The packaging and storage of finished goods are an important part of manufacturing. Goods must be packaged in such a way that they will be protected in storage and shipment. They must also be properly identified to control the storage and shipping of the correct finished goods.

Outcomes:

Upon completion of this activity, the student will be able to:

1. Explain the importance of controlling the packaging and storage of finished goods.
2. Discuss some of the packaging and storage techniques used for finished goods.
3. List and explain some of the methods used to identify finished goods.
4. Determine methods to be used to identify, store and retrieve several different types of finished goods.

Tools, Materials, Machines and Resources:

1. Fales, J., Mervich, G., Sheets, E., & Dinan, J. (1986). Manufacturing. Mission Hills, CA: Glencoe Publishing Company.
2. White, J. A. (1987). Production handbook (4th ed.). New York: John Wiley & Sons Publishers.
3. Samples or list of products to be used in the exercise.

Instructional Strategies:

The instructor will lecture about the various types of product identification systems, as well as the packaging and storage techniques used for finished goods. The group will discuss the importance of these activities to the manufacturing operation. The students will form teams to develop techniques for the identification, packaging and storage of various types of finished products.

Safe Practices:

No safety hazards in this unit of study.

Integrative Skills

Communication:

x Reading
x Writing
x Speaking
x Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

x Assertiveness
x Negotiation
x Listening
x Risk Taking

Change:

x Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications______________________________

Decision Making:

______ Ethical Reasoning
x Logical Reasoning
x Flexibility

Problem Analysis:

x Identification
x Solutions
x Evaluation
______ Implementation

The proper identification, packaging, and storage of finished goods are an important part of the manufacturing process. The control of products after production has been completed is necessary for several reasons. All finished goods must have **material protection**, they must have proper **identification**, and they must have a suitable means of **storage**.

Some means of **material protection** are necessary to prevent damage to products caused by environmental factors. The products are subject to drops during the handling process and must be protected from **shock**. This may be accomplished through the use of various packing materials such as foam products, paper, air bubble plastic materials, plastic coatings, corrugated fiberboard folded inserts, or wood blocking and bracing for larger products. During work-in-process, materials may be stored in special containers or racks custom designed for that material shape. **Corrosion protection** is also required on some products. During production, materials may be coated with a variety or petroleum-based liquids or synthetics as they are moved from station to station. A more permanent coating may be needed to protect the goods during shipping and storage. Such things as plastic dips or waxes, which can be easily removed, may be used. However, permanent coatings such as paint, sealers, varnishes, anodizing or other chemical processes, may be required. Material loads or groups of materials may need to be protected from falling during transport. Shrinkable plastic film or adhesives may be used for this purpose.

Material **identification** is another important factor in controlling materials during production and finished products accountability. A variety of different coding systems are used to identify products. The most basic form or coding might be **labels** affixed to the product or container. Some products have a series of numbers stamped or molded into the product for identification. This might be appropriate for larger products which are handled one at a time. The information could be computerized for record-keeping purposes. **Bar coding** has become one of the most common methods of product identification. During the 1970s, an increased interest in the use of bar codes was stimulated by the grocery industry universal product code (UPC) and its program for automation of the supermarket checkout counter. This is a 10-digit code printed on nearly all grocery product packages, as well as a large number of other manufactured goods. The code identifies the product and the manufacturer. A moving beam reader is used to identify the code on the product. When the product is passed over the beam, or the beam passes over the product depending on the type of system used, the code content is fed into a minicomputer which transmits the necessary information to the user. Inventory balances can be automatically adjusted, reordering initiated, and many other types of data generated to maintain control of finished goods. **Radio frequency (RF)** systems are sometimes used for product identification. RF identification tags consist of small printed circuit boards that contain receiving and transmitting antennae, a small number of discrete components and an integrated circuit chip for data storage housed in a heavy-duty industrial package. These can be programmed at the factory or by the user with special equipment. Microprocessor equipment is used to decode, store, and compare successive inputs to maintain material control. **Magnetic stripe** is another identification method. This system has been more commonly used for such things as bank and charge card transaction recording and security access control. It is also used to a lesser degree for shop floor control, failure analysis tracking, work-in-process tracking, and other similar applications. Automatic identification systems can greatly increase the efficiency and effectiveness in providing up-to-date information and controlling output, which is critical to operations management.

The **storage and retrieval** of finished goods is the last factor to be discussed. Finished products may be stored or shipped immediately after completion. If finished goods are shipped, the main concern is proper packaging for shipment and careful loading of the products. If the product is to be stored, a warehouse or storage area is used. Several methods may be used for storing products. Larger products may be stored on the floor or sometimes stacked. A **stacker** is a series of specially built storage compartments or racks. A special crane runs on rails between the racks to pick up or deliver the products. This may allow for floor-to-ceiling storage of materials. **Unitized** storage of some materials may be necessary. An example of this would be a group of products stacked on a pallet and held together by strapping or shrink wrap. The entire stack of products could then be moved together. This saves time and storage space. Special **trays, bins, and shelves** may also be used to store products. Some of these may be incorporated into carts which are used during production and rolled directly into the storage area. **Automated storage and retrieval systems (ASRS)** may be incorporated into the storage process to increase the speed and accuracy of controlling output goods.

Accessibility and accountability are key concerns in the identification, packaging, and storage of finished goods. Damaged and lost goods can be a high cost factor in the manufacture of products. Close control can minimize these problems and allow for more efficient processing of finished goods. The automation of these systems has greatly improved the effectiveness of packaging and storage of finished goods.

Student Activity Sheet: PPC.014

The students will be divided into teams of 3 to 5 members. Each team will be given a sample or picture of a different kind of finished product. It will be the responsibility of each team to complete the following:

1. Analyze the product - size, shape, type of material, surface finish, weight etc.
2. Determine how the product will be packaged for storage and shipment to the customer. Use drawings and/or explanations to describe packaging techniques.
3. Determine the identification method to be used for the product. Explain the type of system used and why it was chosen.
4. Determine the method of storage to be used. Remember to consider delivery and retrieval of the product to the storage area. Explain and justify the type of storage system used.

Each team will present its findings to the entire group and defend the techniques that were chosen. The group will discuss the various systems and techniques relative to the type of products a company produces.

Alternative Strategies for Activity Number: PPC.014

Activity #1

The students will form teams of 3 to 5 members and design a package to be used for a product. They will consider the type of product, the storage, shipping, and marketing and display aspects of the product. Depending on the facilities available, the students may actually create the packaging materials and package the product.

Activity #2

The students will form teams and analyze the packaging and identification systems used for various products. The instructor will assign different products to each team. The teams will research the products and explain how storage, retrieval, shipping, and marketing would be affected by the packaging and identification systems used for these products.

Learning Check Sheet: PPC.014

Complete the following:

1. List three factors which must be considered in the control of finished products.

   A.

   B.

   C.

2. Special packing materials may be used to protect finished products from ____________________ if they are dropped during handling.

3. ______________________________ may be required for materials which may be damaged by moisture or chemicals.

4. ______________________ is a type of product identification system which involves the use of a 10-digit code printed on the package.

5. A small circuit board and transmitter are used for product identification in a system known as ________________________.

6. A ________________________ is commonly used for identification on charge cards.

7. A series of specially built compartments on which a crane traveling on rails retrieves and delivers products for storage is called a ___________________.

8. ________________________ is accomplished by binding a group of products together for ease of movement and storage.

Discuss the following:

1. Explain the importance of controlling the packaging and storage of finished goods.

2. Explain why identification systems are necessary for finished goods.

Learning Check Answer Key: PPC.014

1. A. Material protection
   B. Identification
   C. Storage
2. Shock
3. Corrosion protection
4. Bar coding
5. Radio frequency
6. Magnetic stripe
7. Stacker
8. Unitized storage

Performance Check: PPC.014

The instructor will evaluate methods of identification, packaging, and storage selected by each team and their justification of their selection. The teams will also be evaluated on their presentation of their findings to the group. Each student will be evaluated on team participation and test performance.

SKILLS MARKETING

GUIDELINES TO REDUNDANT EXPRESSIONS

Instead of...	Use...
and et cetera	et cetera
as otherwise	otherwise
at about	about
attached hereto	attached
avail oneself of	use
be of the opinion	believe
both alike	alike
both together	together
check into	check
connect up	connect
continue on	continue
cooperate together	cooperate
customary practice	practice
each and every	each **or** every
enclosed herewith	enclosed
enter into	enter
forward by post	mail
have a tendency to	tend to
in many instances	often
in the amount of	for
in the matter of	about
in the process of being	being

GUIDELINES FOR EXPRESSIONS TO AVOID

according to our records
acknowledge receipt of
as to, with reference to, with regard to, with respect to
at hand, on hand
attached please find, attached hereto,
beg to inform, beg to tell
duly
enclosed herewith, enclosed please find
for your information
hereby, heretofore, herewith
I have your letter
I wish to thank, may I ask
in due time, in due course of time
in receipt of
in the near future
in view of
our Mr. or Mrs. Jones
permit me to say
pursuant to
thank you again
thank you in advance
thereon

GUIDELINES FOR EXPRESSIONS TO USE

Instead of ...	Use... .
advise, inform	say, tell, let us know
along these lines, on the order of	like, similar to
as per	as, according to
at your earliest convenience or at an early date	soon, today, next week, or a specific date
check to cover	check for
deem	believe, consider
due to the fact that, or because of the fact that	because
favor, communication	letter, memo, et al.
for the purpose of	for
forward	send
free of charge	free
in accordance with	according to
in advance of, prior to	before
in compliance with	according to
in re, re	regarding, concerning
in the event that	if, in case
kindly	please
of recent date	recent
party	person, specific name
said	do NOT use as a adjective
same	do NOT use as a noun
subsequent to	after, since
the writer, the undersigned	I or me

smw.13

GUIDELINES TO REDUNDANT EXPRESSIONS
(continued)

Instead of...	Use...
in this day and age	nowadays
inform of the reason	tell why
letter under date of	letter of
new beginner	beginner
on account of the fact that	because
past experience	experience
place emphasis on	emphasize
place an order for	order
repeat again	repeat
same identical	identical
send an answer	reply
up above	above
write your name	sign

Using the information, samples, and guidelines provided, you should now be able to compose a business letter. Your instructor will provide you with specific details and purpose for the letter. You should then use a typewriter or word processor to generate the appropriate business letter.

FACTORS RELATIVE TO INTERVIEWING

1.	PHYSICAL FACTORS	Excellent condition, attractiveness of appearance.
2.	INTELLIGENCE AND SCHOOLING	Degree of suitability for the position available.
3.	WORK EXPERIENCE	Previous jobs which will have a direct bearing on the position.
4.	STABILITY	Frequency of job changes, type of home life, etc.
5.	INDUSTRIOUSNESS	Progress on jobs, goals, objectives.
6.	ENTHUSIASM	Degree of interest in the position.
7.	FIRMNESS	Able to take a stand when necessary, but not stubborn.
8.	RESPONSIBILITY	Degree of maturity and dependability.
9.	LIKABLENESS	Acceptability by fellow workers, supervisors, and customers.
10.	SOCIABILITY	Desire to be with others and get along.
11.	COMPANY LOYALTY	Likelihood of having this trait.
12.	SELF-EXPLANATION	Clear and convincing NOT confused or illogical.

THE INTERVIEW

There are basic rules and situations common to most interviews which are helpful to know about ahead of time:

1. Nervousness: It's normal for people to be nervous about an employment interview.
2. Take your cues from the interviewer.
3. Be prepared to shake hands, regardless if you are a male or female, and regardless if the interviewer is male or female.
4. Be prepared for surprise questions. One method of handling questions is to restate the question before you answer it. This will make sure you understand the question correctly, and it will buy you some time to formulate an answer.
5. Follow the interviewer's lead. Most interviewers will ask open-ended questions (ones that start with who, what, where, why, when, or how) that you will not be able to answer with a simple "yes" or "no".
6. Sit up in your chair; look alert and interested at all times.
7. Look your interviewer directly in the eyes.
8. Don't let your hands betray nervousness.
9. Some interviewers like to do most of the talking and judge you by your reactions--the interest, comprehension and intelligence you show. Other interviewers say very little. Their attitude is that it is up to you to sell yourself.
10. Make sure that your good points are understood by the interviewer.
11. Most interviews will follow a rather simple question-and-answer format. In this situation, your ability to answer quickly and intelligently is of great importance. If your answers are confused and contradictory, your chances for being hired are reduced.
12. Be ready to give an answer to the question, "What do you plan to be doing 5/10 years from now?" This is a standard question. Pattern an answer along the lines of being more capable and knowledgeable and of more worth to the company.

TYPICAL INTERVIEW FORMAT

I.	Introduction	Simple exchange of pleasantries; the interviewer establishes rapport and creates a relaxed, business-like atmosphere. First Impression Evaluation - Verbal and Non-Verbal - Voice tone, energy, enthusiasm - Posture and Gestures - Body movements (eye contact)
II.	Your Background	The interviewer will try to gain information about your basic skills, educational qualifications, work experience, and interests.
III.	Job and Career Goals	The interviewer begins to match your career interests and qualifications with available positions.
IV.	Questions	A chance for you to ask questions based on your needs and showing your knowledge of the company.
V.	Close	At this point, the interviewer will try to sell you on the company and talk about training, advancement, and benefits. After an opportunity to ask final questions, the interviewer will start to bring the interview to a close.

QUESTIONS FREQUENTLY ASKED DURING THE EMPLOYMENT INTERVIEW

1. What are your future vocational plans?
2. In what school activities have you participated? Why? Which did you enjoy the most?
3. How do you spend your spare time? What are your hobbies?
4. What type of position are you most interested in?
5. Why do you think you might like to work for our company?
6. What jobs have you held in the past? How were they obtained and why did you leave them?
7. What courses did you like best in school? Least? Why?
8. Why did you choose your particular field of work?
9. How did you spend your vacations while in school?
10. What do you know about our company?
11. How do you feel about the general training you have received?
12. What qualifications do you have that make you feel you will be successful in your field?
13. What extracurricular activities were you involved with in school?
14. What type of sports are you interested in?
15. If you were starting school over again, what courses would you take?
16. Can you forget your education and start from scratch?
17. Do you prefer any specific geographic location? Why?
18. How much money do you hope to earn by age 20? 25?
19. How did you rank in your graduating class in high school?
20. What was your grade point average?
21. Do you think that your extracurricular activities were worth the time you devoted to them? Why?
22. What do you think determines a person's progress in a company?
23. What personal characteristics are necessary for success in your chosen field?

QUESTIONS FREQUENTLY ASKED DURING THE EMPLOYMENT INTERVIEW
(continued)

24. Why do you think you would like this particular type of job?

25. Are you looking for a permanent or temporary job?

26. Do you prefer working with others or by yourself?

27. What kind of boss do you prefer?

28. Are you primarily interested in making money or do you feel that service to your fellow man is a satisfactory accomplishment?

29. How do you feel about taking directions or instructions?

30. How were you treated by your teachers? Your previous employers?

31. What have you learned from some of the jobs you have held?

32. What type of recommendations will your previous employers give?

33. What interests you about our product or service?

34. What do you know about the opportunities in this field/industry?

35. How long do you expect to work?

36. Have you ever had any difficulty getting along with fellow students, workers, or teachers? Why?

37. How do you feel about routine work?

38. How do you feel about regular hours?

39. What size city do you prefer to live in?

40. What is your major weakness?

41. What are your strengths?

42. Please define cooperation?

43. In your opinion, how important is teamwork?

44. Have you had any serious illness or injury?

45. How do you feel about going where the company sends you?

46. How do you get along with people whose backgrounds and interests are different from your own?

47. What type of people seem to rub you the wrong way?

QUESTIONS FREQUENTLY ASKED DURING THE EMPLOYMENT INTERVIEW (continued)

48. What jobs have you enjoyed the most? The least? Why?

49. What are your own special abilities?

50. What job in our company would you choose if you were completely free to do so?

51. What job in our company do you want to work toward?

52. Would you prefer a large or small company? Why?

53. What is your theory on how industry operates today?

54. How do you feel about travel as part of your job?

55. How do you feel about working overtime?

56. What are the disadvantages of the field you want to work in?

57. Do you think that grades should be considered by employers? Why?

58. Tell me something about yourself. What do you really want to do?

59. What can you offer?

60. What have you done which shows initiative and willingness to work and learn?

61. Why are you interested in this company?

62. Why should I hire you?

63. What motivates you to put forth your greatest efforts?

64. How do you determine or evaluate success?

65. What two or three accomplishments have given you the most satisfaction? Why?

66. How do you work under pressure?

67. What have you learned from your mistakes?

68. What two or three things are most important to you in your job?

69. How do you feel about relocation to another area?

70. What type of indicator are your grades to what you have learned?

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NETWORKING
(THE HIDDEN JOB MARKET)

When you are unemployed, the most important key to finding a job is YOU. You must consider finding a position a job in itself. The time and energy that you spend on researching companies, writing your resume and contacting prospective employers will pay off for you with a position that is fulfilling for you and well worth the effort it took to find that job.

When people begin to look for a new job, their normal initial search begins with the local newspaper. The fact that millions of people concentrate on help wanted ads is precisely why you should avoid too much reliance on this source. Only a small percentage of actual openings are ever advertised, and your resume will be forced to compete for attention with hundreds of others.

Most individuals do not use a Networking system to let their employment status be known to friends, family, business associates and social organizations. Many people miss the opportunities waiting for them because they do not ask those people who may have heard about an opening.

To start the networking process, you need to contact friends and family to let them know you are looking for a position in your field of interest. You may gather phone numbers, a name of a representative from a company, company names and addresses or leads on job fairs. Keep a record of all information gathered. Contact those companies that may have openings using a friend's name as your referral. This begins opening doors of companies who may not have advertised or have a position that just became available.

When you contact a company it is best to have a representative's name so that you speak directly to the person responsible for interviewing or hiring the new employee. If a representative's name is not available, it is simple enough to call the company and ask the switchboard operator for the name of the Employment Manager, the head of Engineering, or the head of Computer Operations. Whichever avenue you feel will get you closest to a personal interview needs to be followed. Some companies will not discuss job openings over the phone. Many like to prescreen applicants on the telephone before seeing the resume so that they will be closer to a good match of duties, responsibilities, and job experience. However, if a company wishes to proceed, the applicant needs to adapt to the company.

A company who requests resumes first will call if there is an interest. Make sure that the correct spelling is used on the cover letter and send the resume to a person, not a department or company in general. Take the time to find out who the company representative is, and the first impression with that company will be a good one. Also state in the cover letter that it follows the telephone conversation with a company representative. There are hidden sources that many people do not think about when they are attending a social function or business function. People can be successful in gathering names and places by just letting their intentions be known. This is one area that is available to everyone. Many business organizations have newsletters or monthly publications that list openings throughout the local area. Monthly meetings are held which have people coming in from various companies who may be hiring. People should circulate after a meeting and let the employment status be known. This is a source that always needs to be explored. Fellow members may be associated in some manner with organizations such as the American Society of Mechanical Engineers or the Society of Manufacturing Engineers, to name a few. Use these groups as resources.

Social clubs such as church, dancing, travel, etc. are another excellent source to seek out about openings. It is important for people to check with friends in these organizations because they can usually get accurate information about the company with the opening. An employee and friend will usually be honest about the working conditions and prospects of that company's future, as well as its benefits.

Another source of Networking is a direct mail campaign. This approach offers people an additional source for generating interviews. Perhaps the best part of direct mail is it that it is essentially a method of uncovering job opportunities that have not been advertised. Other advantages are that this approach allows people to avoid the competition that exists in the published job market and, at the same time, gives them the opportunity to project their best image. Although the direct mail approach can be expensive, it is an investment which has been proven to be successful.

Prepare a target list of companies. Be sure to check the resources in the library as they provide good ideas about the company and its products or services. Make a list of those companies that are of interest and are likely to best match qualifications and require-ments. After completing a list of prospective employers, mail the resume with a well-written cover letter addressed to the hiring authority, if known, or the Employment Manager listed in one of the business directories.

In the cover letter, avoid use of the term "job hunting" and stress career rather than job orientation. Bear in mind that a mailing list of 100 companies may not produce more than three or four leads. But mailing the same resume with a slightly revised letter to the same 100 companies may produce the same number of responses two or three weeks later.

SCHOOL PLACEMENT OFFICES

All universities, junior colleges, and technical institutes have a job placement or career services office. The schools will post current openings on bulletin boards and in in-house newspapers. It may be to a person's advantage to contact his/her alma mater or a placement office at a school in the area. It may have a mailing list a person can be added to and receive the job openings on a weekly basis. Companies may have part-time or entry-level positions available and can list with a school at no charge.

Many jobs that are listed with the schools never see an outside newspaper, so this area should be used for reference. These listings describe the type of work to be performed, the basic job duties and responsibilities, the hours of work, and even the base salary range. There are usually contact personnel with names and phone numbers so a person can call or send a resume immediately.

Another contact person at the school could be a past instructor or department head. Many times, firms who are looking for top applicants in a particular area will call instructors and ask who the top performers were in their courses.

Alumni offices are another source at the school to utilize. There might be an alumni newspaper available with job listings for more experienced personnel.

Remember there are many avenues available for the individual to learn open positions at schools and colleges. A person needs to make the effort to land the best possible position.

JOB PLACEMENT FAIRS

A good source to use when in the market for a new position is Job Placement Fairs. Throughout large metro area many recruiting services, colleges (recent graduates and alumni) and companies sponsor Job Placement Fairs. They are always advertised in the classified section of the major metro newspapers and in college newspapers and on job posting bulletin boards. Depending on resources, you may hear about them on television or over the radio.

A job placement fair is where a group of companies who are looking for candidates for open positions can gather at one time to see as many applicants as possible. Usually there are 10-20 companies at smaller job fairs and the larger inter-collegiate fairs attract up to 200 companies. Each organization is given a table or booth area where it will have one or two representatives available to prescreen candidates.

When you decide to attend a job fair, you must prepare yourself beforehand because you will be competing with hundreds of other job seekers. You should take an ample supply of your prepared resume to be handed out to each organization you are interested in interviewing with. Also, most colleges will provide a resume book to firms that are unable to attend the fair, so a person may reach firms that have openings that were not published at the event. Most colleges do charge a small fee to the candidates which covers a box lunch the day of the fair. Since a person will most likely be spending the whole day talking with companies, dress in a business-like manner and make the best first impression possible.

When arriving at the job placement fair, don't back away because of the crowd. Being patient and assertive can give an edge over the next candidate. Be prepared to spend time in lines waiting to speak to representatives of many firms. Each candidate will only have about five minutes with a particular company, so be prepared to give pertinent information regarding background and experience during that time.

Some companies have listings set up at their booth so people can see what openings are current. A resume should be left with as many companies as possible. If a firm does not have an opening in a field now, it may have one in the future. Some companies may set up an interview for a future date at their facility if a person fits the basic requirements of the position available. Companies will also be able to provide ample time to discuss an applicant's experiences and work history.

Remember, a company is looking to fill a current opening with the best candidate available. A person needs to keep a positive attitude with each firm to find the best possible opportunity.

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UNIT GOALS

Upon completion of this unit, the student will be able to:

1. Identify his/her personal interests, values, and skills. (Skilsmkt.001, .002, .003)
2. Determine his/her primary communication style. (Skilsmkt.004)
3. Establish realistic job goals. (Skilsmkt.005)
4. Effectively use the telephone to arrange interviews. (Skilsmkt.006)
5. Identify sources of employment. (Skilsmkt.009)
6. Develop an effective resume for marketing manufacturing skills. (Skilsmkt.010, .011)
7. Complete an employment application. (Skilsmkt.012)
8. Write effective cover letters. (Skilsmkt.007, .013, .014)
9. Prepare for and pass simulated oral and written employment tests. (Skilsmkt.016, .017)
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019	DECISION-MAKING WORKSHEET	smw.47

ACTIVITY NUMBER SKILSMKT.001

INTEREST INVENTORY

Description:

This is an exercise to determine a person's interests to be used in seeking employment in the manufacturing area. Students will complete an interest inventory either on the computer or by hand and use its results to help determine their job search direction.

Rationale:

The better people know themselves, the easier it will be for them to make a good match between their qualifications and their future jobs.

Objective:

To complete a personal interest inventory to be used in the job search process.

Tools, Materials, Machines, and Resources:

1. Drake, Beam, Morin, Inc. (1987). *Career navigator* (software career assistance program).
2. *The self-directed search* (assessment instrument). (1986). Psychological Assessment Resources, Inc.
3. *The Strong-Campbell interest inventory* (assessment instrument). (1983). Consulting Psychologists Press.

Instructional Strategies:

After a brief lecture on the importance of self-assessment, the instructor will direct the students to read the information sheet and complete two exercises. This is followed by a self-assessment exercise (either on the computer or one of the samples in the activity). The instructor may prefer to note that the work is completed at this stage, as some students may not want to share this information in a permanent format.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files and disks.

Integrative Skills

Communication:

☒ Reading
☒ Writing
☐ Speaking
☒ Listening

Computation:

☐ Fractions
☐ Decimals
☐ Percents

Personal

Teamwork (Interpersonal):

☐ Assertiveness
☐ Negotiation
☐ Listening
☐ Risk Taking

Change:

☐ Personal Adaption
☐ Professional Adaption

Computer:

☒ Operating Systems
☒ Keyboards
☐ Applications________________________________

Decision Making:

☐ Ethical Reasoning
☐ Logical Reasoning
☐ Flexibility

Problem Analysis:

☐ Identification
☐ Solutions
☐ Evaluation
☐ Implementation

Student Information Sheet Number: Skilsmkt.001

Self-assessment is probably the most important, and the most overlooked, activity relating to the job search process. The Interest Inventory is one of three areas of self-assessment a person needs to help plan a job search. The other two areas are values and skills inventories (covered in later activities).

When completing any self-assessment inventory, whether it is computer generated, a commercial instrument, or one constructed locally, it is critical to be honest with oneself. Do not select answers based on what the class or the teacher think is right. In this type of assignment, there are no RIGHT answers. Changes are made on individual interests in order to build the proper job foundation for a job search.

This activity consists of three worksheets which make up interest inventories. First is **SELF-ASSESSMENT WORKSHEET 1.** Second is **SELF-ASSESSMENT WORKSHEET 2**, and the third is **SELF-ASSESSMENT WORKSHEET 3**. These may be supplemented by other interest inventory forms supplied by the instructor.

Once a person has determined his/her real interests, the first important step in a successful job search is complete. Knowing honest interests will help a person to make intelligent and effective choices when deciding which job is the best choice.

Alternative Strategies for Activity Number: Skilsmkt.001

Group-Developed Interest Inventory: Divide the entire group into small groups of three or four. Have each group make a list of interests. Have a representative from each group write their list on the board. Using a group process, make up a composite list from all items listed. Use this document then for each person to complete his/her own interest inventory. Three different worksheets are included to assist in this exercise.

Learning/Performance Checks for Activity Number: Skilsmkt.001

The only check at this point is for each person to turn in his/her interest inventory. This will not be for a grade, but simply to ensure that the students will have all the tools needed when the time comes to determine realistic job goals.

ACTIVITY NUMBER SKILSMKT.002

VALUES INVENTORY

Description:

This is a short exercise to determine which values are most important to an individual. After completing the activity, students will have a clearer view of the things that are their highest priority.

Rationale:

A clear vision of one's most important values will help in the process of resume planning and career decision making.

Objective:

To complete a personal values inventory to be used in the job search process.

Tools, Materials, Machines, and Resources:

1. Drake, Beam, Morin, Inc. (1987). Career navigator (software career assistance program).
2. The self-directed search (assessment instrument). (1986). Psychological Assessment Resources, Inc.
3. The Strong-Campbell interest inventory (assessment instrument). (1983). Consulting Psychologists Press.
4. Meyers-Briggs type indicator (assessment instrument). (1987). Consulting Psychologists Press, Inc.

Instructional Strategies:

After a brief lecture on the importance of self-assessment, the instructor will lead the students into the values inventory. This individual exercise is designed to help the students determine which values are important to them.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files and disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications____________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Skilsmkt.002

Values are the most deep-rooted beliefs that an individual has. They form the basis for almost every action and decision that one makes, and every opinion one has. Many times a person's values are not clear, because they are so deeply rooted. People develop their values from many different sources (family, friends, church, or the media, to name a few), but once they are established, it usually takes a major event in their lives to change their values. Values stay with a person for a lifetime and affect everything he/she does.

When a person determines what his/her most important values are and writes them on a sheet of paper, that person will be better equipped to write a resume and to make good decisions about jobs and careers. A person should be honest and introspective when completing the worksheet for this activity. The goal is to present oneself as accurately as possible in a job search. Finding a job is a match-making process. A person has to find the correct fit in a company and a job. If honest in this planning stage, a person will make the best possible match.

This activity provides worksheet, **VALUES WORKSHEET**, with a list of values at the top of the page. Divide those values into three categories. Then rank the values in one category. Remember, this will help a person to know himself/herself better and to more accurately determine what to do and where to do it.

Alternative Strategies for Activity Number: Skilsmkt.002

Group-Developed Values Inventory: Divide the entire group into small groups of three or four. Have each group make up a list of values similar to the ones in the worksheet provided. Have a person from each group list their values on the board. Using a group process, combine the group lists into one master list of about 20 items. After a master list has been created, have the individuals create a rank-ordered list of their most important 5 or 6 values.

Two different worksheets are provided, **ALTERNATE VALUES WORKSHEET 1** and **ALTERNATE VALUES WORKSHEET 2**, that students may use to determine values based upon choices between items. These methods are probably more revealing, but also more time-consuming for both the individual and the class.

Learning/Performance Checks for Activity Number: Skilsmkt.002

As with the previous activity, the only check at this point is for each person to turn in his/her values inventory. This will not be for a grade, but simply to ensure that the students have all the tools needed to determine realistic job goals and to create a resume. It might be a good idea for the instructor simply to say that the work is completed at this stage, as some students may not want to share this information in a permanent format.

ACTIVITY NUMBER SKILSMKT.003

SKILLS INVENTORY

Description:

This is an activity designed to give the student a real understanding of what skills really are and ways to determine their marketable skills.

Rationale:

Understanding what skills are and constantly evaluating the skills a person has is essential to getting the best possible job match not just today, but forever.

Objective:

To complete a personal skills inventory to be used in the job search process.

Tools, Materials, Machines, and Resources:

1. Bolles, R. (1989). The 1989 What color is your parachute? Berkeley, CA: Ten Speed Press.
2. Bolles, R. (1978). The three boxes of life. Berkeley, CA: Ten Speed Press.
3. Drake, Beam, Morin, Inc. (1987). Career navigator (software career assistance program).

Instructional Strategies:

The purpose of this individual activity is for the students to determine what their most marketable skills are. After a brief introductory lecture, the instructor should lead the students through the completion of the skills inventory.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files or disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Skilsmkt.003

One of the most common problems in the job search process is creating a realistic job goal. What this boils down to is making a compromise between what a person WANTS to do and what that person CAN do. The best way to arrive at this compromise is to accurately inventory a person's interests, values, and skills. The most difficult one of these may be skills, because no matter what age the job seeker is, he/she tends to think the right skills are not possessed.

To really pin down what skills a person has, a good working definition of skills is necessary. According to the Dictionary of Occupational Titles (D.O.T.), skills are divided into three basic families. These are: (1) Self-Management Skills, (2) Work-Content Skills, and (3) Functional or Transferable Skills. While each family contains a large number of skills, this activity will be most concerned with Functional or Transferable Skills.

Function or Transferable Skills are usually broken down into three categories. These categories consist of action verbs which describe how people act on or with data, people, and things. A sample chart from the D.O.T. is listed below.

DATA	**PEOPLE**	**THINGS**
Synthesizing	Mentoring	Setting Up
Coordinating, Innovating	Negotiating	Precision Working
Analyzing	Instructing	Operating - Controlling
Compiling, Computing	Supervising	Driving - Operating
	Diverting, Persuading	Manipulating
Copying	Speaking, Signaling	Tending
Comparing		Feeding - Offbearing
	Serving, Taking Instructions, Helping	Handling

Probably the best resource to help in this inventory, if a commercial tool is not available, is Richard Bolles' What Color Is Your Parachute? (1989), either text or audio edition. Two worksheets are provided--the **SKILLS PROFILE WORKSHEET** and the **PERSONAL QUALITIES AND WORK PERFORMANCE PROFILE**. Directions are supplied with each, and they will assist in determining a person's marketable skills.

Alternative Strategies for Activity Number: Skilsmkt.003

Use the four-page **Skills Profile** and have each individual complete the profile. This should give each person an accurate picture of his/her skills. Stress that the student needs to be as honest as possible in answering.

Another alternative is to copy pages of the Dictionary of Occupational Titles and then have the students work in small groups to make up lists of typical skills. Each individual can then use the results of a composite group list to inventory his/her skills. This method is much more time-consuming than using a commercial instrument such as the one provided above.

Learning/Performance Checks for Activity Number: Skilsmkt.003

The most important check at this point is to verify, by whatever method deemed appropriate, that each student has compiled a list of skills. It is recommended that each student also answer the following question. Due to time constraints in the classroom, this could be a homework assignment.

> Why is it important to take inventory of your interests, values, and skills, before beginning a job search?

The emphasis here should be that the students understand or are aware of the importance of making the best possible match in the job search process. This can only be accomplished if they first know what they have before they try to market it.

ACTIVITY NUMBER SKILSMKT.004

COMMUNICATION STYLES

Description:

Complete a commercial or group-developed instrument designed to determine an individual's primary communication style.

Rationale:

If a person knows for sure how he/she communicates best, it will help make the best first impression.

Objective:

Determine your primary communication style.

Tools, Materials, Machines, and Resources:

1. Drake, Beam, Morin, Inc. (1987). Career navigator (software career assistance program).
2. Meyers-Briggs type indicator (assessment instrument). (1987). Consulting Psychologists Press, Inc.

Instructional Strategies:

The instructor is strongly encouraged to utilize a commercial package such as the Meyers-Briggs Type Indicator to assist each individual in determining his/her own communication style.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files and disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications____________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Skilsmkt.004

The Career Navigator classifies four communication styles: Intuitor, Sensor, Thinker, and Feeler. A brief explanation of each follows.

Intuitors are leaders able to bypass the restraints of tradition and focus on the heart of an issue. They like to probe and examine issues. They would rather solve problems than implement solutions. They may have difficulty with follow-through details.

Sensors are hard workers who strive to achieve results. They understand situations based on experience rather than theory. They live in the present and like to get things done sooner and better. Because they are action-oriented, they can be impulsive.

Thinkers enjoy working through a problem by weighing solutions to arrive at the most logical approach. They are known for their objectivity and cool thinking under pressure. Thinkers rely on observations and rational principles while avoiding emotionalism. They can be overly cautious and emphasize deliberation at the expense of action.

Feelers value people and their feelings. They are perceptive, aware, and skilled listeners and communicators. They are able to get people to work together, but often can be more concerned with the process than the content of any interaction. They may also assume that their feelings about a particular situation represent the actual facts.

The Meyers-Briggs Type Indicator deals with the four types above but also adds the categories of Extraversion, Introversion, Judging, and Perceptive. This instrument gives more depth to the analysis and also recommends job types. The additional types are given a brief explanation below.

Extroversion means one probably relates more easily to the outer world of people and things than to the inner world of ideas. This type of person likes variety and action, is often good at greeting people, and gets impatient with long, slow jobs.

Introversion probably means one relates more easily to the inner world of ideas than to the outer world of people and things. This type of person likes quiet for concentration, tends to be careful with details, dislikes intrusions and interruptions, works well alone, and sometimes has trouble communicating.

Judging means one probably likes a planned, decided, orderly way of life better than a flexible, spontaneous way. This type of person works best when a plan of work can be followed through.

Perceptive probably means one likes a flexible spontaneous way of life rather than a planned, decided, orderly way. This type of person adapts well to changing situations. The person does not mind leaving things open for alterations, but may start too many projects and have difficulty in finishing them.

As you have read about these types, you have probably seen some of yourself in each of them. The most important thing about using a standardized, commercial instrument like the Meyers-Briggs, is it can ask you questions and based upon your answers, accurately classify you according to primary type.

The Meyers-Briggs instrument combines the four types from the Career Navigator and then elaborates even more according to the eight total types. First there are: Sensing + Thinking, Sensing + Feeling, Intuition + Feeling, and Intuition + Thinking. It then take the eight types and contrasts them to give four composites.

For example, a person would be classified as either Extraversion or Introversion, Sensing or Intuition, Thinking or Feeling, and Judging or Perceptive. You are then given 16 descriptions for your composite such as the one below for ENFJ.

> Responsive and responsible. Generally feel real concern for what others think or want, and try to handle things with due regard for other person's feelings. Can present a proposal or lead a group discussion with ease and tact. Sociable, popular, sympathetic. Responsive to praise and criticism.

Communication style preferences seem to have an impact on the type of occupations people select. A job search offers an opportunity to improve your ability to influence others by developing and extending your range of communication styles. After completing this activity you will learn how you like to look at things and how you like to go about deciding things. Knowing your own preferences and learning about other people's can help you understand where your special strengths are, what kinds of work you might enjoy, and be successful doing, and how people with different preferences can relate to each other and be helpful to one another.

Alternative Strategies for Activity Number: Skilsmkt.004

One method that could be used, although not recommended, is a group created instrument. Using the information sheet and other references, the class could be split into groups for each type. Have each group make up questions with regard to type to be answered on a Likert scale (strongly agree to strongly disagree). Then combine the questions and use the results to form a composite type.

Since this type of activity would be very time-consuming and lack both standardization and validity, the use of an alternative strategy for this activity would not be encouraged. The use of a commercial instrument is easier to utilize.

Learning/Performance Checks for Activity Number: Skilsmkt.004

If the instructor or counselor administers the instrument, results will be easy to organize and evaluate. The important idea with this activity is to create an awareness in the student of his/her strengths and weaknesses with regard to communication styles.

ACTIVITY NUMBER SKILSMKT.005

INDIVIDUAL JOB GOALS

Description:

Using the results of interest, values, skills, and communications style inventories, determine the best places to market your talents.

Rationale:

Only if people know where they're going can they choose the best route (the one with the least number of hazards or detours).

Objective:

Establish realistic job goals.

Tools, Materials, Machines, and Resources:

The results of Worksheets smw.01-smw.008.

Instructional Strategies:

The instructor should strongly reinforce the rationale for this activity. After a brief motivational lecture, the students should read the information sheet and then use the results of Worksheets smw.001-smw.008 to write a Realistic Job Goal using the format provided. Allow some thinking time for this activity (at least overnight) and assist each individual in writing his/her goal.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files and disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
__x__ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

__x__ Personal Adaption
__x__ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Skilsmkt.005

People are the most successful when they have all of their assets working all of the time. For most people, this is an unrealistic statement. But it does make sense that the more talents, skills, and abilities people use, the more successful they will be.

The main reason for examining all the self-assessment activities prior to this point is to accurately determine what your actual interests, skills, talents, and abilities are. Now this information must be used to set a realistic job goal.

Your job goal should be patterned after this statement:

> By ____(a specific date)____ I will have an entry level position in the ___(your choice)___ industry, doing ___(fill in a job description which utilizes a majority of your skills and interest)___
> ______________________________
> for ___(fill in the minimum amount you will work for)___ in the ___(fill in the location where you desire to work)___.

This is known as defining the ball park you are going to play in. In the employment assistance industry, three pieces of information are needed to help people find positions: (1) a realistic compromise between what they want to do and what they can do, (2) where they want to do it, and (3) how little they will do it for. With these things in mind, a person must write realistic job goals.

A specific date is required because a time line is needed to work under. If people don't have a due date, they may not get the assignment finished.

It is recommended that people try to narrow their work field as much as possible when first beginning. This is why they are asked to choose an industry they wish to build a career in. Remember, this is an industry such as aerospace, biomedical, chemical, etc., not a company or job classification. Another reason for defining the industry is that it will cause people to do some research and hopefully choose an industry that is on the rise (called a "sunrise industry") and not on the decline (called a "sunset industry").

The job description section can be as long as necessary to incorporate as many of your skills, interests, values, and styles as possible. The job description should be based only upon strengths, and they should be as numerous as possible. It should not be written as it might appear in a newspaper advertisement. People won't find a position that uses all of their talents, but it is best to list as many as possible at first. They can always make the description smaller or narrower as they investigate actual positions and try to make a match up themselves. Remember too, that this is an ongoing process. "Nothing is written in stone" as the old saying goes.

When it comes to the minimum amount of money a person can work for, that does not mean it's what the person desires. This section is designed to stimulate thought about how much money is needed to make ends meet. Many times people refer to this amount as "the monthly nut they have to crack." Consider here what it will cost for food, clothing, housing, transportation, and entertainment. Don't be excessive; be realistic. Once an amount is determined for monthly needs, convert a realistic hourly salary, less deductions, into a monthly amount and see how close the two figures match. The income should exceed the payments.

The last item is location. This can be approached in one of two ways. The first way is to determine how great a distance or driving radius a person can or will cover, such as "anywhere within a 50-mile radius" or "anywhere within 30 minutes driving time." The other way is to set definite limits such as "Only north of highway one and west of seventh street and within a 20-minute drive." What people must remember here is that the more restrictive they are here, the lower their odds of finding rewarding employment.

In summary, people should realize that the first goal sheet they write will probably be far from the actual one they market themselves with. This job search process is a constant one of refining. A person writes, compares, rewrites, compares, and then rewrites again. People should not get discouraged in this process because the better the foundation they build on, the better their end product will be. Please use the worksheet, **REALISTIC JOB GOAL STATEMENT**, provided.

Alternative Strategies for Activity Number: Skilsmkt.005

Have students collect newspaper advertisements and job postings for positions they would like to have. Give each student a job description at random. Then have the students describe why that position would or would not be a good match for them based upon their previously determined interests, skills, values, and style.

Give each student several job descriptions and have them prioritize them based upon their interests, values, skills and style.

Learning/Performance Checks for Activity Number: Skilsmkt.005

Students will turn in to the instructor a completed Realistic Job Goal Statement for evaluation.

ACTIVITY NUMBER SKILSMKT.006

TELEPHONE TECHNIQUES

Description:

Distribute short information sheet on phone do's and don'ts. Group practice with four per group. Interchange roles between applicant, switchboard, secretary, and the hiring authority.

Rationale:

Knowing how to make the best use of the telephone will save time in the job search process.

Objective:

Based upon the results of team efforts, effectively use the telephone to arrange interviews and conduct follow-up.

Tools, Materials, Machines, and Resources:

Desks, several nonworking telephones, and audio or video recording equipment.

Instructional Strategies:

Instructor should emphasize the usefulness of the telephone as a resource and marketing tool. Students should be given time to read the information sheet and to prepare the phone telecharts (at least overnight). Students should then be set up in groups for role playing. Environment is important here. It is very difficult to get students to role play seriously when 20 or more classmates are watching. Group isolation and recording equipment are essential for this activity to be a success.

Safe Practices:

Take care not to erase previously recorded tapes.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
______ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

______ Assertiveness
______ Negotiation
______ Listening
______ Risk Taking

Change:

______ Personal Adaption
______ Professional Adaption

Computer:

___x___ Operating Systems
___x___ Keyboards
___x___ Applications____word processing__________

Decision Making:

______ Ethical Reasoning
______ Logical Reasoning
______ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
______ Evaluation
______ Implementation

This activity involves learning a procedure for making cold calls to arrange interview appointments. The telephone is a truly amazing instrument, and knowing the best ways to use it can save a person much time. Success on the phone depends on three things.

First is overcoming any fears a person might have of using the telephone. Second is having a definite purpose for using the phone; and third, having a fixed procedure or plan to use once a connection is made.

When it comes to getting over the fear of using the telephone to arrange interviews, a person should ask himself/herself what is the worst thing that could possibly happen when a phone call is made. No matter what the reason, the worst thing that can happen is that an interview appointment is not arranged. What is important to know, when this occurs, has two parts: (1) A person must be prepared to get some "No's" when he/she starts using the telephone. Most professional telephone callers use the rule-of-thumb that they must make 10 calls before they can get a "Yes" which translates to a 10% success ratio. (2) When a person does get a "No," remember it's not because the person is bad, it's because the company does not need the person's product or service at the time. If a person keeps these two things in mind, and continues to dial those numbers, his/her success ratio will go up.

A person should not make a business phone call without having a clear, distinct purpose for doing so. It may help to write down in big, bold letters next to the phone something like: "I AM MAKING THESE CALLS TO ARRANGE AN INTERVIEW APPOINTMENT IN ORDER TO GET A POSITION THAT WILL BEGIN MY CAREER IN MANUFACTURING" or words to that effect. Most important, have a purpose. Know why the phone call is being made.

The best tool for making phone calls is a **TELECHART WORKSHEET**. This is a written-out script of what is going to be said and done once a person is on the telephone. The major purpose of this activity is to help people develop their own **TELECHART WORKSHEET** and give them some practice using it. The **TELECHART WORKSHEET** consists of five sections. First is an opening. Then ask for permission to talk or find out if it is convenient to talk now. Next is the introduction and reason for calling. Then create an interest, and finally, close by asking for an appointment.

In this activity, each person will complete a **TELECHART WORKSHEET**. Then the class will be divided into small groups and provided with a recording device. Class members will take turns playing the roles of applicant, switchboard/receptionist, secretary, and the hiring authority. The instructor should check the **TELECHART WORKSHEETS** before the exercise begins.

Alternative Strategies for Activity Number: Skilsmkt.006

Use the **TELECHART WORKSHEET** provided with the information sheet in conjunction with assigned telephone calls using other instructors or counselors. Give the student background data and have each student prepare a **TELECHART WORKSHEET** individually. Then record the students when they call the instructor or counselor and critique the calls with them individually.

Learning/Performance Checks for Activity Number: Skilsmkt.006

The check for this activity is a completed Telechart and the recording (either audio or video) of their phone conversations. Students should be graded on creativity, originality, and their sincerity.

ACTIVITY NUMBER SKILSMKT.007

BUSINESS LETTER GUIDELINES

Description:

After given an information sheet explaining basics and the specifics, each person will write a business letter and submit it for evaluation.

Rationale:

Today more than ever before, during a time called the "national literacy crisis," industry needs people who can write effective letters. In the job search process, you must be able to communicate clearly in writing to gain access to hiring authorities.

Objective:

To be able to write effective business letters.

Tools, Materials, Machines, and Resources:

Microcomputers with word processing software or typewriters, good bond paper, and a business letter writing guide of the instructor's choice.

Instructional Strategies:

The objective here is for each individual to write a business letter. Use of a word processing system is highly encouraged. Students should read the information sheet and then use the guidelines to produce a good letter. Personal attention will be required here. If possible, seek assistance from English and Business colleagues.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files and disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications___word processing________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
_____ Evaluation
_____ Implementation

One thing must be clear form the beginning of this activity, and that is: a person will not be an expert business letter writer as a result of this activity. The purpose of this activity is to create an awareness of how important it is to be able to write a good business letter.

Writing of any kind is usually not something that technical people enjoy doing, but more and more in this high-tech information age, technical people must not only do work, but be able to write about it. One of the hardest things for a technical person to become accustomed to in writing is the lack of specific guidelines. Usually in a technical environment, there is always a right answer. When a person writes letters, there are usually a number of different styles to choose from and general guidelines for each. What this information sheet will do is provide you with one example of a business letter that can used for reference. This is not to say that it is the "right," or the only way of producing a business letter. It is meant simply as a guideline to get a person started. For assistance, please refer to the worksheet entitled **PARTS OF THE BUSINESS LETTER.**

One of the first things to consider when it comes to a business letter is style. An inexperienced writer will probably sound too businesslike. In order to help in this regard, three different worksheets have been provided: (a) one, **GUIDELINES FOR EXPRESSIONS TO AVOID**, deals with some expressions to be avoided in a business letter; (b) another, **GUIDELINES FOR EXPRESSIONS TO USE**, provides a list of suggestions of what to use instead of commonly used inappropriate phrases; and (c) the last worksheet, **GUIDELINES TO REDUNDANT EXPRESSIONS**, contains redundant expressions and what to use in place of them.

The next area of interest in a business letter is the format and letter style. The most common letter styles are: Full-Blocked, Blocked, Semi-Blocked, Square-Blocked, and Simplified. For this activity, we will use only the Full-Blocked style and a standard format to follow.

Business letters should be single-spaced, with double-spacing between paragraphs. Paragraph breaks should occur at logical points and all paragraphs should appear even. The letter should be pleasing in appearance. This means that appropriate margins should be at the top, bottom, and both sides.

There are two basic styles of punctuation. One is called the Open Style, and uses no punctuation except in the body of the letter. The other is called the Standard Style. It uses a colon after the salutation and a comma after the complimentary close. Our format will use the Standard Style of punctuation.

Using the information, samples, and guidelines provided, you should now be able to compose a business letter. Your instructor will provide you with specific details and purpose for the letter. You should then use a typewriter or word processor to generate the appropriate business letter.

Alternative Strategies for Activity Number: Skilsmkt.007

Give the students samples of business letters. Divide them into groups. Then grade the letters based upon the guidelines provided in the activity. They should check grammar, style, and format.

Learning/Performance Checks for Activity Number: Skilsmkt.007

The letters generated by the students should be evaluated for grammar, style, and format.

ACTIVITY NUMBER SKILSMKT.008

INTERVIEW PREPARATION

Description:

Information sheets provide guidelines and questions to practice. Choose the questions from the guidelines provided. Then record each person as he/she role plays interviewer and interviewee.

Rationale:

Without proper preparation, the results of any performance will be poor. To interview well, a person must first practice for the interview.

Objective:

Using a group process, practice for the job interview.

Tools, Materials, Machines, and Resources:

Interview rooms with some degree of privacy, desks and chairs, recording equipment--audio will do, but video is preferred. Several different job descriptions applicable to the student level.

Instructional Strategies:

Using the information sheet and guidelines provided, the students should decide in small groups what questions will be asked. They will need to be provided with a job description appropriate for their skill level. After questions are determined, the students should be split into groups of twos for practice interviews. Each person should be recorded playing the role of the interviewer and the interviewee. It is VERY important to critique the recording as a class, but always in a nonthreatening way for the individual.

Safe Practices:

Exercise care so as not to erase a previous interview recording.

Integrative Skills

Communication:

___x___ Reading
______ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

___x___ Assertiveness
___x___ Negotiation
___x___ Listening
___x___ Risk Taking

Change:

______ Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications______________________________

Decision Making:

___x___ Ethical Reasoning
___x___ Logical Reasoning
___x___ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
___x___ Implementation

Student Information Sheet Number: Skilsmkt.008

The purpose of this activity is to practice what to do in an actual interview. It is not intended to cover all situations that may occur in a job interview situation. There will be another activity later in the course which will cover all phases of the interview. The present activity has two basic parts.

The first part will involve working in small groups whose purpose will be to select 20 questions from a large list to be used in the simulated interview situation. The questions should be selected based upon the relevance to the job description distributed by the instructor. After the questions have been decided upon, each person will have an opportunity to play the role of interviewee and interviewer. These sessions will be video/audio taped for playback and critique later.

This activity is not designed to embarrass anyone or to make anyone feel uncomfortable. The whole idea is to make people realize just how important it is to practice for an interview before they go to it.

Rehearsing an interview is almost impossible because one doesn't know what cues will be given. The best guide is to adapt and be flexible for any given situation. The interviewers are there because they want to hire the best applicants, not to confuse or embarrass them.

Worksheets and basic rules are provided that have helped others in preparing for an interview. The first worksheet, **FACTORS RELATIVE TO INTERVIEWING**, overviews areas of an interviewee that are evaluated. The second worksheet, **THE INTERVIEW**, covers basic rules for interviewing. The third, **TYPICAL INTERVIEW FORMAT**, breaks down the interview process; and the fourth, **QUESTIONS FREQUENTLY ASKED DURING THE EMPLOYMENT INTERVIEW**, provides 70 sample interview questions. With these aids, a person should be able to choose 20 questions and make this a good learning experience. Questions should be chosen to provide a good selection for each section of the interview. Use the **TYPICAL INTERVIEW FORMAT** guide to choose questions for each area. Remember, the more a person practices, the better the final result will be.

Once each person has had the opportunity to be both interviewer and interviewee, the instructor will critique each person's performance from the recordings. This activity will require each person to accomplish much in a short amount of time. To make this a success requires cooperation between everyone involved.

Twelve areas are listed in Worksheet smw.15 where a person will be evaluated during an employment interview. Some areas will carry more weight than others, depending on the type of position being applied for.

Review this section to discover your strong and weak points. Keep in mind each individual will be high in some areas and low in others, but no one is 100% in every area.

Alternative Strategies for Activity Number: Skilsmkt.008

Work in small groups the first day to decide on questions that will be asked for a specific job description. Use group process to form composite list of questions for each category in the **TYPICAL INTERVIEW FORMAT**. Let each student take the official questions home to study overnight. The next day, set up to give each person a short interview. Add a question that has not been rehearsed to give the interview a sense of realism.

This method has the advantage of recording each student as he/she is interviewed, but can be more time consuming. The important point in this activity is that students get an awareness of what will probably occur in the interview and how important it is to practice, even though they never know for sure what will happen at the interview.

Learning/Performance Checks for Activity Number: Skilsmkt.008

With the time constraints involved, it is best to evaluate the recordings of each interview, rather than use some written test. The interviews require much more involvement and participation and are no more difficult to evaluate than written work if some simple guidelines are followed.

Pay attention to first impressions and body language. Sometimes what people show, but don't say, has more meaning than what they say. Write a job description for a position that students can fill. Then list some qualifications to determine using the **TYPICAL INTERVIEW FORMAT** guide and the questions the students have chosen.

Decide if the student conveys the message that "I can do the job and I want to be part of the team." Then critique the recording based upon gut feeling with respect to that message. This, after all, is what will happen in an actual interview.

ACTIVITY NUMBER SKILSMKT.009

SOURCING FOR EMPLOYMENT

Description:

A group activity designed to create an awareness of what sources are available for finding employment. Requires at least two different group projects. Also involves ranking sources and reporting.

Rationale:

A person who knows what sources are available and how to use them will be more successful in the job search than the individual who depends on only one source.

Objective:

To be able to evaluate sources to determine which offer the best opportunities for employment.

Tools, Materials, Machines, and Resources:

Newspapers, Reference section of library, and school placement representative.

Instructional Strategies:

The information sheet describes the activity. The purpose here is to establish communication among the students, as they are first in one group to learn about a sourcing method, then in another group to teach others about the different methods, and lastly to decide upon a method for an unknown individual. Maintaining group dynamics for multiple groups is essential for this activity.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

x Reading
x Writing
x Speaking
x Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

x Assertiveness
x Negotiation
x Listening
x Risk Taking

Change:

x Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________

Decision Making:

_____ Ethical Reasoning
x Logical Reasoning
x Flexibility

Problem Analysis:

x Identification
x Solutions
x Evaluation
x Implementation

Student Information Sheet Number: Skilsmkt.009

Sourcing for employment means knowing what resources are available and being able to evaluate which ones will be the most effective. This activity seeks to create an awareness of five basic sourcing areas. Worksheets are provided on each of these sources to explain them in detail.

Each student will not be expected to read each worksheet for this activity, although it is recommended for future use. The group will be divided into teams of five people each. Teams will meet for a brief time to get an understanding of the area to which they are assigned. Teams will then be split into new groups, each of which should have a representative from each of the five original areas.

These last groups will then familiarize each other with the types of sources available. Once everyone in the group is familiar with these sources, the instructor will give each group a short resume on a make-believe person. Each group will then decide how to utilize the sources to best market this person.

The sourcing areas to be covered, by worksheet title, are: **NETWORKING (THE HIDDEN JOB MARKET), SCHOOL PLACEMENT OFFICES, JOB PLACEMENT FAIRS, AGENCIES, CLASSIFIED ADVERTISING, AND REFERENCES AND DIRECTORIES.**

Alternative Strategies for Activity Number: Skilsmkt.009

Through lecture, discussion, and homework, familiarize the students with the different sources available. Have each student write a short report explaining what sources he/she plans on using, which one feels the best, and why.

Through lecture, discussion, and homework, get the students familiar with the different sources available. Then have each student rank the sources and list advantages and disadvantages of each.

Learning/Performance Checks for Activity Number: Skilsmkt.009

Have each student write one paragraph explaining why "Networking" is the best possible source to use when seeking employment.

ACTIVITY NUMBER SKILSMKT.010

GROUP RESUME WRITING

Description:

Small groups assist each other in getting started on a resume by developing write ups on common areas when given some basic guidelines.

Rationale:

To get an offer of employment, a person must first obtain an interview. One of the most important tools used to obtain an interview is the resume.

Objective:

To work together developing common areas of a resume for manufacturing positions.

Tools, Materials, Machines, and Resources:

1. Drake, Beam, Morin, Inc. (1987). Career navigator (career assistance program software).

Instructional Strategies:

This is a group activity for individual resume writing. Students will work in small groups to help each other complete educational, training and employment worksheets. Student groups should be monitored closely after they have read the information sheet to encourage timely completion of the worksheets. It should be emphasized that they will need these to complete their individual resume assignments.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files or disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications____ C/N and W/P______________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Student Information Sheet Number: Skilsmkt.010

EASY GUIDE TO STARTING THE RESUME

The objective of the resume is to create a desire on the part of the reader to see the applicant in person--to arrange an INTERVIEW. The resume, when properly utilized, becomes the most powerful tool in the employment-seeking tool chest. The resume should be an attractive, well-organized fact sheet--NOT a life history. It should be printed on good quality, white or neutral-colored paper in a clear format, and NEVER be folded. The resume is simply a calling card, designed to create a desire in the prospective employer to arrange an interview.

A practical way to handle all the information gathered in self-analysis is to present a resume personally or by mail, to potential employers. The purpose of the resume is to get interviews. The resume, if planned and executed with the right techniques, will be an attention-getting document. It must clearly say to an employer: "I will be valuable to your company." Remember, the purpose of the resume is to create a desire on the part of the employer to arrange the personal interview.

A GOOD RESUME MUST:

1. Be clear, use short, concise sentences without technical jargon or confusing construction.
2. Provide the reader with an easy-to-follow format which highlights the important points.
3. Have all irrelevant material eliminated.
4. Be directed to the audience. Use the vocabulary of the receiver and speak that person's language.
5. Have all periods of time accounted for and most recent experience emphasized. Industry/product lines of past employers must be clear.
6. Present and include all skills and accomplishments. Convey clear benefits to a potential employer.
7. Use power words. Verbs tell a stronger story than nouns.
8. Be professional in appearance; type neatly and proofread carefully before duplicating on good-quality paper.

To assist in the development of a resume, three worksheets have been included. The **EMPLOYMENT APPRAISAL** worksheet will be used to help develop descriptions of any jobs previously held. The **EDUCATION AND TRAINING** worksheet is provided to assist in getting as much relative information in the resume as possible about any type of training and education. One last guideline, **THE STANDARD RESUME**, is provided to give an example of the general format of the finished product.

Students will be asked to work in small groups in developing these two worksheets. The reason for working in groups is primarily to assist each other think of accomplishments and ways to describe them, that might not be thought of individually. Working in groups also helps to proof your work. One of the most difficult things to do is proofread one's own work. By assisting each other, everyone will all have a better product in the end.

In the next activity, the results of this group activity will be used to produce an individual resume to help in marketing manufacturing skills.

Alternative Strategies for Activity Number: Skilsmkt.010

The most important function of this activity is to get on paper much of the data that will make up the final resume product. How the students get this information down can be done in a number of different ways and the suggested format in the activity is just one. The students could complete the worksheets as homework and then work in groups to refine them after the instructor has had a chance to lecture on the importance of getting the information down.

It is critical that the students work in groups for at least part of this activity. Experience has shown that several heads working together for the same goal generally produce better results. It will also help reinforce the concept of teamwork as they move to the work force.

Learning/Performance Checks for Activity Number: Skilsmkt.010

Verify that the students have completed the employment, education, and training worksheets. These are critical to the next step of preparing an individual resume. Critique the students' worksheets from a positive approach. Encourage them to put down on paper more than they will probably need. This will be pared down in the next activity, where they must create a powerful, concise, one-page resume.

ACTIVITY NUMBER SKILSMKT.011

INDIVIDUAL RESUME WRITING

Description:

Using information developed in the previous activity, each person should create his/her own individual resume. Guidelines and worksheets are provided.

Rationale:

The resume is a marketing proposal, an advertisement selling an individual! People are seldom hired solely by their resumes, but job hunters are often rejected because of poorly written resumes.

Objective:

To develop an effective resume for marketing manufacturing skills.

Tools, Materials, Machines, and Resources:

Microcomputer with word processing software and/or the Career Navigator software package.

Instructional Strategies:

Instructor should provide a brief resume summary lecture and then encourage students to read the information sheet and guidelines and ask questions regarding the assignment to make sure they understand exactly what is expected of them. They should be given an appropriate out-of-class time period to submit the resume worksheet which should be critiqued so they may use it to develop their final draft.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files or disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
_____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications ___C/N and/or W/P___

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Student Information Sheet Number: Skilsmkt.011

The purpose of the resume is to obtain an interview with a prospective employer. Since many employers use resumes as screening tools, it must stand out from the hundreds the recruiter may scan. It must be readable, attractive, and it must emphasize skills related to your career objective.

Now that a number of worksheets and some self-analysis have been completed, the next step is pulling it all together. A number of handouts and worksheets for this process will be provided. The first step is format and it is provided on the **RESUME WORKSHEET**. It is possible to go to libraries or bookstores and get dozens of "how-to" books on resumes. Remember that there is no "right" way to create a resume. In a way, a resume is like a computer program. If it works, it must be right. The program may not run as fast as possible, or be as memory-efficient as possible, but it gets the job done. The resume is much the same. This activity is most concerned with providing good, common sense guidelines and the creation of an effective resume. This resume will provide a foundation for a person to build on for the rest of his/her work career.

While putting together a rough draft, some other worksheets have been included to help. While constructing the resume, please refer to:

1. **FREQUENTLY MISSPELLED WORDS** - One misspelled word on a resume may eliminate you as a contender. An employer assumes a person is putting his/her best foot forward! Always double-check and have someone else proofread your work.
2. **SUGGESTED ACTION WORDS FOR RESUME WRITING** - This list gives suggested words to describe activities in a more active, interesting, and powerful manner.
3. Use **FINAL CHECKPOINTS** to produce a high-quality product.

To ensure creation of a quality product, it needs to be proofread. This is usually better accomplished by an outside source, or a "fresh" set of eyes. Have at least one other person proofread for typing errors, misspellings, grammatical errors, or format changes. Always get another opinion.

The best situation is one where a trained professional critiques the resume. Use instructors and counselors to assist with this project. The resume will always be one of the most important "tools" in the job-hunting "tool box."

Alternative Strategies for Activity Number: Skilsmkt.011

The most important function of this activity is for students to finish with a working resume upon which they can build for the rest of their work career. Whatever resources can be used to accomplish this objective should be put into action.

Learning/Performance Checks for Activity Number: Skilsmkt.011

The final product is a working resume for marketing skills in a manufacturing environment. Each person's work should be evaluated with this purpose in mind, and adjustments made accordingly. Remember that this tool will be needed in the actual job interview simulation in a later activity.

ACTIVITY NUMBER SKILSMKT.012

EMPLOYMENT APPLICATION

Description:

Using worksheets, each individual will complete a sample employment application form.

Rationale:

The employment application stays in the company files long after the applicant has gone. It must be complete, accurate, and create a desire in the reader to arrange a personal interview.

Objective:

To practice and complete an employment application to be used as a guide for filling out applications for any position, with any company.

Tools, Materials, Machines, and Resources:

Worksheets and blank employment applications.

Instructional Strategies:

The students are required to submit a clean, clear, and concise employment application. They should be given enough blanks and encouraged to use the guidelines and information sheet. Ample time should be allowed for a quality product. They need to understand that the better they do on this document, the better all that follow will be (and they'll be the real thing) because they will have this as a reference.

Safe Practices:

None.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
____ Speaking
____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Skilsmkt.012

This activity will require the student to complete an application for employment. This is not a difficult assignment, because most of the information put on the form is "cut and dried," that is to say, you don't have a lot of flexibility; the facts are recorded and they speak for themselves. What must be done, though, is to make sure that the facts are neat, accurate, and concise.

To help students fill out the blank application form, they will be provided with some worksheets and some basic guidelines to follow. Two of the worksheets have already been completed in Skilsmkt. 010. They are the **EMPLOYMENT APPRAISAL** worksheet, smw.25, and the **EDUCATION AND TRAINING** worksheet, smw.26. In addition, they will be given the **REFERENCES** worksheet, smw.32.

Using these worksheets and the previously completed resume, the student will complete an application form that can be taken to any interview and used as a guide to complete an application for most companies. The first test an applicant will get when going to an interview will be the application form. Companies know how long it should take to complete one. If the student completes his/hers from a prepared guide, it will be done efficiently, accurately, and neatly.

One thing becomes obvious about most application forms--they provide very little room to write what most people consider a large amount of information. This is why the student must practice on a sample form like the one in this activity. With practice, the student will be able to say the most in the least amount of space. Doing one's very best in completing this activity will pay dividends in the future.

What follows are some recommended guidelines for completing employment applications. They are not rules to be taken literally, but simply guides which have helped people in the past.

1. Be sure to read and follow directions on the form. Remember the exercise on following directions in the first activity.

2. Do NOT write "See Resume" on the application unless told to do so by the employer. Many times, the resume and application are separated and the application is the only document available about you after you've gone.

3. Do NOT request a specific salary. Instead, put "OPEN" where they request salary. This gives you some latitude when discussing salary. It also gives the impression that money is not the only interest, that a person would be open-minded enough to accept a lower salary in exchange for growth potential in the position.

Alternative Strategies for Activity Number: Skilsmkt.012

None.

Learning/Performance Checks for Activity Number: Skilsmkt.012

Evaluate the students' final application form. Students should be given as many blank forms as necessary to create a neat, concise, and accurate form. The emphasis here is to practice until it is the best that it can be, until the students are able to virtually compress a paragraph from their resume into a single, powerful sentence on the application form. Once the form has been evaluated, it can be used by the student whenever he/she has to complete an application form.

ACTIVITY NUMBER SKILSMKT.013

GROUP COVER LETTER DEVELOPMENT

Description:

Following simple guidelines, class will divide into small groups and develop a cover letter for an instructor-provided application.

Rationale:

A well-written cover letter will introduce you and create interest on the employer's part to see you.

Objective:

Using a group process, develop a cover letter for an instructor-provided application.

Tools, Materials, Machines, and Resources:

Microcomputer with word processing software or typewriter. Suitable area for small groups to work without disturbing other classes or groups.

Instructional Strategies:

The procedure here is much the same as for the resume, but the time required should be less. The students are divided into groups and use the information sheet and samples to develop a cover letter. The instructor must provide job openings or position descriptions for the skill level of the students.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files and disks.

Integrative Skills

Communication:

☒ Reading
☒ Writing
☒ Speaking
☒ Listening

Computation:

☐ Fractions
☐ Decimals
☐ Percents

Personal

Teamwork (Interpersonal):

☒ Assertiveness
☒ Negotiation
☒ Listening
☒ Risk Taking

Change:

☒ Personal Adaption
☐ Professional Adaption

Computer:

☒ Operating Systems
☒ Keyboards
☒ Applications Word Processing

Decision Making:

☒ Ethical Reasoning
☒ Logical Reasoning
☐ Flexibility

Problem Analysis:

☐ Identification
☐ Solutions
☐ Evaluation
☐ Implementation

Student Information Sheet Number: Skilsmkt.013

WRITING A SUCCESSFUL COVER LETTER

A well-written cover letter is crucial because it can serve two very important functions: it serves to introduce you and spark a decision maker's interest, or it can be used to follow up your phone calls to a friend, neighbor or relative, reminding them that you are serious about your job search and that you would like their assistance. Actually, your cover letter is really a personal introduction to the record of your working life as revealed in the resume that accompanies it. Your homework should include a call to the company to find out the correct spelling of the hiring authority's name, his/her exact title and the full name of the company. Like the resume, a cover letter should be neatly typed on good-quality paper and should include your full name and address. Use action verbs to convey participation, involvement, and accomplishments. They produce a strong impact on the reader. Avoid conventional or stereotypical words or phrases. Your resume will be the product and your cover letter the packaging. If you have the time, a cover letter is most effective when it is customized to its reader. You could begin by writing a comment or two on the company--perhaps concerning recent developments you have read or heard about within the field and how your work experience might fit in. Close by suggesting an interview--your ultimate goal.

In this activity, you will be provided with a worksheet, **THE COVER LETTER**, and **SAMPLE COVER LETTER 1** and **SAMPLE COVER LETTER 2**. You will then be divided into groups to create a cover letter for a specific situation, which your instructor will provide. Work together to produce the best possible cover letter possible. Your next activity will require each individual to write a cover letter for a specific job. Use this group process time to your best advantage.

Alternative Strategies for Activity Number: Skilsmkt.013

Provide groups with a cover letter written for a given application and have the group improve the letter using the guidelines provided.

Provide groups with a cover letter and after using the guidelines to critique it, have a spokesperson present his/her opinions to the class for overall evaluation.

Learning/Performance Checks for Activity Number: Skilsmkt.013

Verify that the group work has been accomplished. No specific assignment will be done for a grade in this activity. The main purpose of this activity is preparation for the next activity where each individual will submit a cover letter for a grade.

ACTIVITY NUMBER SKILSMKT.014

INDIVIDUAL COVER LETTERS

Description:

Using worksheets and group results, individuals write letters for given application. Each person will be provided with a job description and company information by the instructor.

Rationale:

The cover letter will not only act as an introduction to the employer, it should create an interest on the part of the employer to interview you.

Objective:

Write a cover letter for a given job description with a local company.

Tools, Materials, Machines, and Resources:

Microcomputer with word processing software or typewriter.
Suitable facilities for individual to research, develop, and write letters.

Instructional Strategies:

This follows the individual resume-type activity. The students should use the information sheet and samples to apply for a specific position with a company. These positions must be provided by the instructor. Ample out of-class-time should be provided to complete this assignment. Not as much time should be needed as for the resume.

Safe Practices:

Proper use of microcomputer so as not to erase or reformat established files and disks.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
_____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

__x__ Operating Systems
__x__ Keyboards
__x__ Applications __Word Processing__________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

_____ Identification
_____ Solutions
_____ Evaluation
_____ Implementation

Student Information Sheet Number: Skilsmkt.014

The previous activity provided a number of worksheets, examples, and practice at developing cover letters. This activity will require you to write a cover letter by yourself for a job at a local company. Your instructor will provide you with a job description. It will be up to you to research the company to find out details for your letter. You will need to find out what the company does, how it compares with other companies in its industry, and who to address the letter to. You will be provided with a short list of DO's and DON'Ts, a worksheet, **COVER LETTER FORMAT**, and two more samples, **SAMPLE COVER LETTER 3** and **SAMPLE COVER LETTER 4**.

COVER LETTER DO'S

A cover letter should:

- Be written to a specific person, using his/her name and title. Correct spelling!
- Demonstrate that you know something about the firm.
- Highlight your accomplishments, and your fitness for the job.
- Use action-packed words to relate your accomplishments.
- Suggest an interview to discuss career opportunities.
- Indicate times and availability. Repeat your phone number.
- Be neatly typed and folded.
- Be one page in length, with three to four paragraphs.
- Be kept short and to the point.

COVER LETTER DON'TS

A cover letter should:

- Not have any content that you cannot substantiate in a personal interview.
- Not write for a particular job unless you are interested in it.
- Not use sympathy or any sense of urgency as a lever for forcing the interview.
- Not use gimmicks or any form of boasting.
- Not contain any materials with misspelled words, incorrect information, or typing errors; it must look professional.

Alternative Strategies for Activity Number: Skilsmkt.014

None.

Learning/Performance Checks for Activity Number: Skilsmkt.014

Individually created cover letters should be turned in for evaluation. Grade on the basis of following format, being original, and creating interest.

ACTIVITY NUMBER SKILSMKT.015

INDIVIDUAL JOB SEARCH PLAN

Description:

After finishing self-assessment, covering sourcing, and creating basic tools, each individual develops a job search plan.

Rationale:

Without a plan, even the best intentions can go astray. By using all the knowledge and tools accumulated up to this point, you logically decide where you are going and how you are going to get there.

Objective:

Develop an effective job search plan and maintain clear records of contacts, resumes sent, follow-ups, and interviews.

Instructional Strategies:

The instructor should lecture on the importance of an organized job search campaign and maintaining accurate records of work in progress. Each individual should be required to make logical goal statements also.

Tools, Materials, Machines, and Resources:

Worksheets and resources from previous activities.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
_____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications________________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Student Information Sheet Number: Skilsmkt.015

You can't hit the target, unless you know what and where the target is! Define what you are searching for.

KNOW:

- The kind of company/industry you are interested in.
- The level of responsibility you are capable of.
- The "target position."
- The location and size of desired employer.
- The atmosphere and working environment of target company.
- The target company's hiring procedures.
- The target company's current business outlook.

After answering the questions above, you are ready to construct an effective job search plan. Your plan may fall into one of two categories:

1. Specific to a certain position you know to be available and are specifically targeting.

2. A general plan, constructed to be used for "multiple targets," but specific enough to accomplish your goal.

Every activity prior to this has been a building block. You have gathered information about yourself and available employment opportunities. Now you must, with the aid of a few more worksheets, create a plan that you will follow to find the position that is best for you.

Two of the three new worksheets are types of diaries or logs. They will help you keep track of all the activity you have going in your job search. These two are: **INTERVIEWS IN PROGRESS** and **RESUMES SENT TO NEWSPAPER ADS**. The third, **THE COMPANY FACT SHEET**, will help you better target a company for the type of position you seek.

What you must do now, is to create a plan for obtaining a position using all the tools and information you have gathered to date. Your plan must include a time line. This will require you to set realistic goals, such as "By this date I will have made the initial contact with the hiring authority at ______________ company, for the position of ________________________________."

Once you have committed the above statement to paper for a number of companies, you will then begin a cycle of follow up until you have either arranged for an interview, or exhausted the lead. When you have arranged for the interview, you must practice the next three activities as well as what you were given in Activity Skilsmkt.008.

Alternative Strategies for Activity Number: Skilsmkt.015

Using the plan statement in the information sheet, require the students to submit a list of five companies they will begin their job search with, based upon using a directory chosen by the instructor. Or use the above procedure, but require the students to use a certain edition of the local newspaper to base their plans on. These methods will probably be less time-consuming, but they actually defeat the purpose of having the students learn about sourcing for employment. Let time constraints be the deciding factor.

Learning/Performance Checks for Activity Number: Skilsmkt.015

For evaluation, have the students complete **THE COMPANY FACT SHEET** for at least one company on their plan. Base evaluation upon realistic completion of the fact sheet. The more information the student has gathered on a target company, the better his/her chances of success. Base the number of completed sheets required upon the time available, but not less than one.

ACTIVITY NUMBER SKILSMKT.016

ORAL EMPLOYMENT TESTS

Description:

The class will divide into small groups and prepare lists of possible technical and manufacturing questions that might be asked at an interview. They will also prepare answers for these questions.

Rationale:

You must be able to convince the interviewer that you not only have the best interpersonal skills for the job, but you are also technically competent.

Objective:

Be able to pass a technical oral exam in the interview process.

Tools, Materials, Machines, and Resources:

Pencils, worksheets, and a suitable area for small groups to work without disturbing each other.

Instructional Strategies:

The instructor should divide the class into small groups. Each group will use the worksheets provided to make up questions and answers they might face in an interview situation. Groups need to be monitored closely for relevant activity.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

_____ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

_____ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

During the course of this curriculum, you have studied many aspects of the manufacturing process. Now you are studying how to market the skills you have acquired. During the interview, you will be evaluated as to how well you fit into the work force (interpersonal skills) and how knowledgeable you are about the trade (technical skills).

You have studied Safety, Measurement, Product and Process Control, Quality, and Business Economics. You can expect to be asked questions from each of these areas during the interview. They may seem informal or they may be very specific, such as asking you to describe how you see a particular print or schematic functioning. Regardless of how the question is asked, you must prepare for them and do the very best you can in answering them.

In order to answer questions in the best possible manner, you must PRACTICE. In this activity you will be divided into small groups and asked to do two things. First you must make up at least three questions from each area you have studied, which you think an employer might ask during an interview, and then you must provide a good answer to the question. Do not gloss over this exercise and make the questions simple and easy to answer. Make the questions ones that require the students to think and will show that they know their material technically.

When you have made up the questions and answers, then practice them on each other. Whenever you are asked a question during the interview that you do not have an immediate answer to, a technique you can use to buy thinking time and to formulate an answer, is to restate the question. Practice this with each other until you feel comfortable with an oral technical exam.

Use the worksheet **ORAL EXAM QUESTIONS AND ANSWERS** provided to make up your questions and answers.

Alternative Strategies for Group Number: Skilsmkt.016

Use the same worksheet and small groups, but have a group for each of the areas of study. One group will concentrate on questions and answers for Quality, another for Safety, and so on. Then compile the questions and give each group two or three questions from each area to practice answering.

Learning/Performance Checks for Activity Number: Skilsmkt.016

There is no written work for grade on this activity. The instructor needs to monitor the groups closely to verify relevant activity. Assistance from another instructor or counselor might be considered to better monitor group activity.

ACTIVITY NUMBER SKILSMKT.017

WRITTEN EMPLOYMENT TESTS

Description:

Each individual contributes one question and answer from each previous area of study to a comprehensive manufacturing test. The instructor will use this test bank to create a composite test and administer it to the class.

Rationale:

An employment interview many times requires you to pass a written test before seeing anyone personally. Proper preparation for this step is essential to interviewing.

Objective:

To be able to pass a written employment test.

Tools, Materials, Machines, and Resources:

Pencils and worksheets.

Instructional Strategies:

Students will be required (on their own time) to read the information sheet and submit questions for a written employment test. Set FIRM deadlines for submission and use their input to construct an actual written test for their final interview.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
_____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

_____ Ethical Reasoning
_____ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

You may be required, by some companies, to pass a written technical test before you are granted an interview. The purpose of this activity is to allow you to not only practice for this test, but to have input into its creation.

Written tests are generally created with one purpose and two rules in mind. The purpose is to evaluate the applicant to see if he/she has the basic skills necessary to do the job. All questions are then aimed at testing for this knowledge. The first rule deals with ease of grading. To grade the test, the applicant should be able to answer the questions with a minimum amount of writing. The second rule calls for the questions to deal with the basics of the position being tested for. Complex methods and ideas are better left for the oral interview.

In this activity, you will be required to generate one question and answer for each of the five areas studied. After the instructor collects everyone's questions, they will be compiled into test form and administered to the class. Do your very best on this assignment because it will help you prepare for passing the real thing, and it will also help your classmates.

To satisfy the main purpose of the test, make sure that your question deals specifically with the information you have studied in previous units. Also be sure to write the question so that it is relevant to the type of position you would be applying for.

To make a test easy and quick to grade (not necessarily easy to pass), choose questions that use the multiple choice, fill-in-the-blank, matching, or true/false format. If you choose the multiple-choice format, be sure to give thought to your choices. In test-making terms, these are called "distractors," because they distract you from the real answer. List the answer and three distractors. Don't make the distractors obvious, you want the test taker to have to think, and you really want to test his/her basic knowledge.

The second rule deals with testing the basics. You want to make sure the applicant is qualified in the most basic sense before you invest time in a personal interview. Keep the questions related to the basic principles in all areas. Once the person has proven he/she know the basics, more detailed information can be gathered in the actual interview.

Use the supplied worksheet **TEST QUESTIONS** to generate your test questions.

Alternative Strategies for Activity Number: Skilsmkt.017

Select written tests from the other five units of study and give them to the students for study guides. From these, choose five questions from each area and construct an entry-level test. Give students time to prepare and administer this test with established levels for passing. Stress to the students that passing the written test is required before they will be granted an interview.

Learning/Performance Checks for Activity Number: Skilsmkt.017

This activity is for a grade. The student must pass the employment test in order to get to the last stage--the interview. Offer repeat tests for those who do not pass the first time, but limit the number of times. This should be a prerequisite for the actual interview.

ACTIVITY NUMBER SKILSMKT.018

INDIVIDUAL EMPLOYMENT INTERVIEWS

Description:

Each person will be required to dress, be at the right place at the right time, and be interviewed. All persons will interview for similar positions. Seek assistance from other instructors, counselors, and advisory committee members. This should be video recorded (or at least audio) for critique.

Rationale:

This is the culmination of all the preparation in the units before this. Doing well in the 30 minutes or so of the interview may determine the future course of your life for some time to come.

Objective:

To prepare for and complete a simulated employment interview.

Instructional Strategies:

This is the most important activity in the unit. It must be planned carefully and executed properly. It requires assistance from people who have experience interviewing young people. These could be counselors, coop coordinators, advisory committee members, or other instructors. Each student must be given a legitimate company name, a position description, and an appointment time.

The applicant should bring a resume to the interview and be prepared to complete an application form and possibly take a written or oral test. This must be as realistic as possible. Time is the most critical factor, so it is important to enlist the help of other professionals.

The interview should be video recorded (or at least audio) and played back for individual critique with the applicant later. The interviewer should evaluate the person for the description provided, decide if he/she will be made an offer, and how much the offer should be. The applicant should also be explained a standard benefit package decided upon by the interviewers. This information will be used in the next activity, evaluating a job offer. It is best for the interviewer to assume unlimited openings so that we have a large number of hires (if the students do their job) and let the starting salary determine grade (if necessary).

Tools, Materials, Machines, and Resources:

Facilities simulating as close as possible an actual employment interview. These should include offices, secretaries, and practiced interviewers. This MUST NOT be taken lightly by anyone concerned.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
___x___ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

______ Assertiveness
______ Negotiation
______ Listening
______ Risk Taking

Change:

___x___ Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications______________________________

Decision Making:

___x___ Ethical Reasoning
___x___ Logical Reasoning
___x___ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
___x___ Implementation

Student Information Sheet Number: Skilsmkt.018

The previous activities that have been done up to this point have been in preparation for the interview. This activity will consist of the actual thing. You will be required to report to a certain place, at a certain date and time, and to be interviewed by a specific person for the type position you have been training for. While this is a simulated interview, you should put maximum effort into this activity so you will benefit as much as possible for the real interviews which will follow.

You are to use all worksheets and guidelines you have accumulated so far. In addition, three more have been supplied with this activity. the first, **THE PROTOCOLS OF INTERVIEWING, HANDOUT 1**, is a list of interview Do's. The second, **THE PROTOCOLS OF INTERVIEWING, HANDOUT 2**, is a list of interview Don'ts. The third, **WAYS APPLICANTS "STRIKE OUT" ON INTERVIEWS**, provides information on pitfalls to avoid during the interview.

You will be provided with a job description and a company name by your instructor. You will also be assigned an appointment time and place. Take a resume with you to the interview and be prepared to fill out an application form and to take oral or written entry tests. Use all your new marketing "tools" from your job search "tool box" and good luck in your interview!

Alternative Strategies for Activity Number: Skilsmkt.018

The interview is the most important activity in the whole unit. It can NOT be neglected. It should be planned and practiced for by all participants. It should be video recorded and time allowed to meet with each interviewee to critique his/her performance.

Use whatever means at your disposal to conduct an interview, but do it for sure. Do NOT make the mistake of thinking the student has all the tools and now they can go out and use them. Let the students make the initial mistakes where they don't get penalized by no job offer.

Learning/Performance Checks for Activity Number: Skilsmkt.018

This activity should count a major portion of the final grade for this unit. This activity culminates the study. Assign grades based upon punctuality, accuracy, test results, appearance, and performance.

ACTIVITY NUMBER SKILSMKT.019

EMPLOYMENT OFFER EVALUATION

Description:

Each person will decide on accepting an offer extended for the interview completed in the previous activity. The individual is required to give reasons for accepting or rejecting the offer.

Rationale:

The objective of the interview is to get an offer of employment. When the offer is extended, you must have some criteria established upon which you can make your decision.

Objective:

Evaluate offers of employment based upon previously determined realistic Job Goals.

Tools, Materials, Machines, and Resources:

Job Goal statement from Activity Skilsmkt.005; employment offer based upon the interview in Activity Skilsmkt.018.

Instructional Strategies:

Each student will be given an offer of employment and asked to evaluate it based upon his/her own realistic job goals. He/she must submit a written acceptance or rejection of the offer with a reason statement based on logic. Each individual should be critiqued one-on-one based on his/her response.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
_____ Writing
_____ Speaking
_____ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

At the completion of the interview, several options are open to the interviewer. He/she could:

1. tell you they must meet and compare notes before making a decision, or
2. tell you there are more people to interview and they will be in contact, or
3. tell you that you are definitely in the running, but you will have to interview again, or
4. make you an offer then and there.

Whatever occurs, at the end of the interview, you must let the interviewer know that if an offer is extended, you will accept it. No one wants to be rejected, not even the interviewer, so before you finish the interview, let him/her know you want the job.

When you ask for the job, you are not committing yourself to the position. Only after you have received an offer, can you make a decision. The important point is to get the offer.

Once you have an offer of employment, it is best to make a decision quickly. You don't want to keep the company waiting too long, or they may have second thoughts about your interest in the position.

When making your decision about an employment offer, start with the Job Goals you established in Activity Skilsmkt.005. Compare your Goals with the offer and then make a list of reasons why you should accept the offer. Then make a list of all the reasons why you should reject the offer. With these in mind, you should be able to decide.

Generally, if an offer satisfies 70 to 80 percent of your desires or goals in a position, it is acceptable. Remember that the chances of getting an offer that satisfies 100% of your goals is not very likely. Another thing to consider is that you may get a better offer in the future. Since no one is effective at predicting the future, think about the old saying, "A bird in the hand is worth two in the bush." This simply means having something for sure is better than what you MIGHT have in the future.

For this activity, your instructor will provide you with an offer of employment letter detailing the position, salary, and location. Use the worksheet, **DECISION-MAKING WORKSHEET**, provided and your Job Goal from Activity Skilsmkt.005 to make your decision. You will be required to submit your decision in writing, with reasons for accepting or rejecting the offer, to your instructor.

Alternative Strategies for Activity Number: Skilsmkt.019

Divide class into small groups and provide each group with a job offer and a goal statement. Have each group complete the **DECISION-MAKING WORKSHEET** and then provide time for a class discussion. Each group should have a spokesperson present their decision and allow a few minutes for discussion by the entire class.

Learning/Performance Checks for Activity Number: Skilsmkt.019

Regardless of the method used to arrive at a decision, each student should be required to turn in the acceptance/rejection/reason statement. This should be evaluated as to logic and sincerity, and then critiqued with the individual.

SKILLS MARKETING WORKSHEETS

BEST COPY AVAILABLE

LIST OF SKILLS MARKETING WORKSHEETS

Activity Number		File Name
001	SELF-ASSESSMENT WORKSHEET 1	smw.1
	SELF-ASSESSMENT WORKSHEET 2	smw.2
	SELF-ASSESSMENT WORKSHEET 3	smw.3
002	VALUES WORKSHEET	smw.4
	ALTERNATE VALUES WORKSHEET 1	smw.5
	ALTERNATE VALUES WORKSHEET 2	smw.6
003	SKILLS PROFILE WORKSHEET	smw.7
	PERSONAL QUALITIES AND WORK PERFORMANCE PROFILE	smw.8
005	REALISTIC JOB GOAL STATEMENT	smw.9
006	TELECHART WORKSHEET	smw.10
007	PARTS OF THE BUSINESS LETTER	smw.11
	GUIDELINES FOR EXPRESSIONS TO AVOID	smw.12
	GUIDELINES FOR EXPRESSIONS TO USE	smw.13
008	GUIDELINES TO REDUNDANT EXPRESSIONS	smw.14
	FACTORS RELATIVE TO INTERVIEWING	smw.15
	THE INTERVIEW	smw.16
	TYPICAL INTERVIEW FORMAT	smw.17
	QUESTIONS FREQUENTLY ASKED DURING THE EMPLOYMENT INTERVIEW	smw.18
009	NETWORKING (THE HIDDEN JOB MARKET)	smw.19
	SCHOOL PLACEMENT OFFICES	smw.20
	JOB PLACEMENT FAIRS	smw.21
	AGENCIES	smw.22

LIST OF SKILLS MARKETING WORKSHEETS
(continued)

Activity Number		File Name
009	CLASSIFIED ADVERTISING	smw.23
	REFERENCES AND DIRECTORIES	smw.24
010	EMPLOYMENT APPRAISAL	smw.25
	EDUCATION AND TRAINING	smw.26
	THE STANDARD RESUME	smw.27
011	RESUME WORKSHEET	smw.28
	FREQUENTLY MISSPELLED WORDS	smw.29
	SUGGESTED ACTION VERBS FOR RESUME WRITING .	smw.30
	FINAL CHECKPOINTS	smw.31
012	REFERENCES WORKSHEET	smw.32
013	THE COVER LETTER	smw.33
	SAMPLE COVER LETTER 1	smw.34
	SAMPLE COVER LETTER 2	smw.35
014	COVER LETTER FORMAT	smw.36
	SAMPLE COVER LETTER 3	smw.37
	SAMPLE COVER LETTER 4	smw.38
015	INTERVIEWS IN PROGRESS	smw.39
	RESUMES SENT TO NEWSPAPER ADS	smw.40
	THE COMPANY FACT SHEET	smw.41
016	ORAL EXAM QUESTIONS AND ANSWERS	smw.42
017	TEST QUESTIONS	smw.43
018	THE PROTOCOLS OF INTERVIEWING, HANDOUT 1 . .	smw.44
	THE PROTOCOLS OF INTERVIEWING, HANDOUT 2 . .	smw.45

Activity Number		File Name
018	WAYS APPLICANTS "STRIKE OUT" ON INTERVIEWS	smw.46
019	DECISION-MAKING WORKSHEET	smw.47

SELF-ASSESSMENT WORKSHEET 1

Think about jobs you have held in the past, as well as your current position.

WHAT AREAS DO YOU EXCEL IN?

WHAT DO YOU CONSIDER YOUR PRIMARY STRENGTHS?

WHAT AREAS DO YOU HAVE TO WORK EXTRA IN?

WHAT WOULD YOU LIKE TO IMPROVE ABOUT YOURSELF AND YOUR JOB PERFORMANCE?

SELF-ASSESSMENT WORKSHEET 2

One important aspect of choosing a position is understanding yourself. Self-evaluation can help you analyze what is important to you in the kind of work you will do and the kind of organization in which you will work.

The following are some of the things you should consider in your own self-evaluation. Your answers should be honest. They are meant to help you and should not represent a "good" or "bad" value judgment.

1. What are the things you do best? Are they related to people, or things?

   ________________________related to______________________________________
   ________________________related to______________________________________
   ________________________related to______________________________________

2. Do you express yourself well and easily?

   Orally: Yes_____No_____In writing: Yes______No_______

3. Do you see yourself as a leader of a group or team?

   Yes_____No______

   Do you see yourself as an active participant of a group or team? Yes_____No_____

   Do you prefer to work on your own? Yes_____No_____

   Do you like supervision? Yes_____No_____

4. Do you work well under pressure? Yes_____No_____

   Does pressure cause you anxiety; in fact, is it difficult for you to work well under pressure?

   Yes_____No_____

5. Do you seek responsibility? Yes_____No_____

   Do you prefer to follow directions? Yes_____No_____

6. Do you enjoy new ideas and situations? Yes_____No_____

   Are you more comfortable with known routines? Yes_____No____

7. In your future, which of the following things are most important to you:

   a. Working for a regular salary ___________
   b. Working for a commission_______________
   c. Working for a combination of both_______

SELF-ASSESSMENT WORKSHEET 2
(continued)

8. Do you want to work a regular schedule (e.g., 9 a.m. to 5 p.m.)? Yes_____No_____

9. Are you willing to travel more than 50 percent of your working time? Yes_____No_____

10. What kind of an environment is important to you?

    a. Do you prefer to work indoors? Yes____No____
    b. Do you prefer to work outdoors? Yes____No____
    c. Do you prefer an urban environment (population over a million)? Yes_____No_____
    d. Do you prefer a rural setting? Yes_____No_____

11. Do you prefer to work for a large organization?

    Yes_____No_____

12. Are you free to move? Yes_____No_____

    Are there important "others" to be considered?
    Yes_____No_____

SELF-ASSESSMENT WORKSHEET 3

Personal Interests (hobbies, community organizations, volunteer work, and other activities in which your accomplishments show transferable skills):

smw.3

VALUES WORKSHEET

Instructions: Listed below are some words that describe commonly held values. Write each word under the heading which most applies to you (Most Important - Sometimes Important - Not Important). These lists should define how YOU feel about these values. When you have listed each value in one of the three categories, rank the values you have listed as Most Important in their order of importance. Use #1 as the highest priority value for YOU.

VALUES

Achievement
Balance
Career Advancement
Challenge
Change/Variety
Competition
Creativity
Friendship
Independence
Integrity
Knowledge
Leadership
Leisure Time
Management
Money
Personal Growth
Physical Activity
Power
Security
Service to Society
Status
Work with Others

MOST IMPORTANT	SOMETIMES IMPORTANT	NOT IMPORTANT
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________

MOST IMPORTANT BY RANK

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________

ALTERNATE VALUES WORKSHEET 1

Please answer all questions. You MUST choose either A or B. Check the answer you prefer.

IN DESCRIBING YOURSELF, WHICH WORDS BETTER FIT YOUR PERSONALITY?

A B

(1) physically active, a can-do person.....____OR____mentally active, an idea person

(2) sociable, friendly....................____OR____able, forceful

(3) informal, congenial...................____OR____formal, sensible

(4) practical, down-to-earth..............____OR____persuasive, influential

(5) flexible, cooperative.................____OR____thoughtful, dutiful

(6) inventive, artistic...................____OR____systematic, orderly

(7) busy, hard-working....................____OR____insightful, knowledgeable

(8) methodical, procedure-minded..........____OR____hard-driving, aggressive

(9) precise, painstaking..................____OR____creative, imaginative

(10) inner-directed, individualistic.......____OR____outer-directed, group-minded

(11) frank, straightforward................____OR____careful, particular

(12) adventurous, broad-minded.............____OR____cautious, security-minded

(13) realistic, well-grounded..............____OR____gentle, considerate

(14) companionable, good talker............____OR____purposeful, action-minded

(15) enthusiastic, warm hearted............____OR____settled, deep-rooted

(16) forthright, plain spoken..............____OR____agreeable, easy going

(17) likeable, generally pleasing..........____OR____self-reliant, independent

(18) kindhearted, humane...................____OR____disciplined, well-balanced

ALTERNATE VALUES WORKSHEET 1
(continued)

IN DESCRIBING YOURSELF, WHICH WORDS BETTER FIT YOUR PERSONALITY?

A B

(19) watchful, restrained..................____OR____energetic, go-getter

(20) steadfast, never-say-die..............____OR____alert, on-your-toes

smw.5

ALTERNATE VALUES WORKSHEET 2

Please answer all questions. You MUST choose either A or B. Check the answer most descriptive of you. MOST PEOPLE FEEL UNDER PRESSURE WHEN THINGS GO WRONG. UNDER INTENSE STRESS, YOU TEND TO BECOME:

		A		B	
(1)	unfeeling, pitiless............	____	OR	____	too sensitive, tenderhearted
(2)	hasty, act without thought......	____	OR	____	hesitant, slow in making decisions
(3)	too permissive, too trusting....	____	OR	____	too reserved, not friendly
(4)	insecure, indecisive............	____	OR	____	rigid, will not bend
(5)	careless, negligent.............	____	OR	____	difficult to please, nit-picking
(6)	too cautious, too exacting......	____	OR	____	restless, irritable
(7)	impractical, rattled............	____	OR	____	narrow-minded, inflexible
(8)	hostile, hot-tempered...........	____	OR	____	unruly, rebellious
(9)	hard-hearted, ruthless..........	____	OR	____	opinionated, argumentative
(10)	anxious, fearful................	____	OR	____	overzealous, fanatical
(11)	meddlesome, manipulative........	____	OR	____	resigned, withdrawn
(12)	overbearing, domineering........	____	OR	____	pig-headed, won't compromise
(13)	soft hearted, too emotional.....	____	OR	____	heartless, unmerciful
(14)	abrupt, impulsive, curt.........	____	OR	____	listless, passive, sad
(15)	reckless, overconfident.........	____	OR	____	overcautious, over-particular
(16)	too familiar, overstep bounds...	____	OR	____	negative, too grudging
(17)	unyielding, stubborn............	____	OR	____	hot-headed, insistent
(18)	flighty, easily upset...........	____	OR	____	hairsplitting, too picky
(19)	high-handed, arbitrary..........	____	OR	____	too daring, use poor judgement
(20)	dictatorial, iron-handed........	____	OR	____	big talker, bluffer

ALTERNATE VALUES WORKSHEET 2

A B

(21) visionary, too idealistic.......____OR____windbag, brag too much

(22) conceited, cocky................____OR____uncertain, doubtful

SKILLS PROFILE WORKSHEET

Directions: Review the following skill titles and descriptions. Place a check mark in the space to the right of each one that you feel is a strong skill for you. Then circle specific portions of the skill descriptions that apply to you and add further descriptions as necessary.

Skill Title	Descriptions	A Strong Skill For Me
Athletic	Sports (individual, team); outdoor recreational sports (hiking, skiing, bicycling, climbing);	
	Other_______________	_______________
Artistic	Drawing; painting; designing; appreciation of music, theater, art; writing;	
	Other_______________	_______________
Communication	Writing; speaking; proficient use of grammar, vocabulary; knowledge of foreign languages; ability to explain effectively; goodtelephone skills, good reception ability; ability to persuade;	
	Other_______________	_______________
Creative	Innovative; imaginative; idea person;	
	Other_______________	_______________
Interpersonal relations	Ability to get along well with others; friendly; dependable; cooperative; thoughtful; diplomatic; good teamwork ability; flexible; patient; understanding;	
	Other_______________	_______________

Skill Title	Descriptions	A Strong Skill For Me
Management	Ability to lead, initiate, organize, develop; self-directed; ability to manage time effectively, solve problems, guide and motivate others, analyze data and make decisions;	
	Other____________________	____________
Manual/ Mechanical	Good manual dexterity; ability to build, operate, repair, assemble, install, carry, load, ability to cook, drive;	
	Other____________________	____________________
Mathematical	Strong mathematical computation ability; accurate; proficient in accounting, financial planning and management, statistical problem solving, economy planning and management, cost effectiveness analysis, budgeting; detail-oriented;	
	Other________________	________________
Office	Keyboarding (word processing, data processing equipment operation); filing; business math; record keeping; bookkeeping; composing general correspondence; determining work priorities; good telephone/reception skills;	
	Other________________	________________
Sales/ Promotion	Ability to persuade, negotiate, promote, influence, sell; enthusiastic; good product knowledge; proficient in business math;	
	Other______________	________________

Skill Title	Descriptions	A Strong Skill For Me
Outdoor	Farming; animal care; landscaping; grounds care; boating; navigating; oceanographic studies; forestry; logging; mining; fishing; horticulture; plant cultivation;	
	Other____________________	____________________
Performing	Speaking; dancing; singing; acting; musical performance; comedy; conducting;	
	Other____________________	____________________
Scientific	Investigating; researching; compiling; analyzing; systematizing; observing; diagnosing; evaluating;	
	Other____________________	____________________
Service/ General	Service-oriented work (serving, referring, receiving, billing, handling complaints, customer relations); good listening skills; patient in dealing with troublesome or difficult people; willingness to help others; ability to relate to others;	
	Other____________________	____________________
Service/ Medical	Nursing; diagnosing; treating, curing; guiding; counseling; consoling; sympathetic; ability to handle stress/emergencies well;	
	Other____________________	____________________
Other	____________________	____________________
	____________________	____________________

smw.7

PERSONAL QUALITIES AND WORK PERFORMANCE PROFILE
(To be completed by job seeker)

Directions: Rate yourself on each of the personal qualities and work performance characteristics listed below using a scale of high, average, or low. For example, if you feel you have a high degree of initiative, write "high" in the space to the right of "Initiative." If you feel you have an average degree of energy, write "average" in the space to the right of "Energy level," and so on.

Personal Quality or Work Performance Characteristic	Rating
Initiative	
Dependability	
Punctuality	
Flexibility	
Creativity	
Perseverance	
Diplomacy	
Intelligence	
Energy level	
Motivation	
Ability to handle conflict	
Ability to set and achieve goals	
Ability to plan and organize work	
Ability to determine priorities of work	
Outgoing personality	
Cheerful personality	
Optimistic attitude	
Realistic attitude	
Enthusiastic attitude	
Willingness to work	

REALISTIC JOB GOAL STATEMENT

By ______________________________ I will have an entry-

level position in the ____________________ industry,

doing ____

____

____

____

____

____

____

____

for ____

in the ____

____area.

smw.9

TELECHART WORKSHEET

OPENING:

The Magic Ten Words

Use the person's name three times, "please" once, and "thank you" once.

"Mrs. Fran Paxton, please"

Their reply

"Mrs. Paxton?"

Their reply

"Thank you, Mrs. Paxton (and now you get permission to continued)"

THIS GENERAL OPENING MAY HAVE TO BE MODIFIED SLIGHTLY FOR EACH CALL BUT SHOULD BE FOLLOWED AS CLOSELY AS POSSIBLE, DEPENDING ON WHO YOU CONTACT INITIALLY.

PERMISSION: Something as simple as, "I will need about a minute to explain why I'm calling Mrs. Paxton. Is it convenient to talk now?" may work. The important thing to remember is that time is valuable for both of you, so find out early in the conversation if it's okay to continue or if you should call back at a more convenient time.

Their reply

INTRODUCTION: My name is Richard Blair and I recently sent you a resume seeking a position in your manufacturing department. I would like to verify that you have received it and arrange an interview with you.

Their reply

INTEREST: Depending upon the reply above, you want to generate an interest in seeing you in person without letting them interview you over the telephone. A suggestion would be to let the person know that you are informed about the company and have skills to assist in the direction they are heading. "I have just completed two years of study in the Manufacturing Technology curriculum at Lords High School and have been trained in many of the methods used at your company. I would like to be a member of the **'Company'** team as you move toward **'One of Their Goals.'**"

Their reply

CLOSE: When closing, and asking for an appointment, it is best to give the person choices. Example: "Would it be possible to have an interview this week, or would next week be better?" "Week" can be replaced with days or times.

TELECHART WORKSHEET
(continued)

OPENING: M___ __________ ____________________ please

M__ __________?

Thank you, M___ __________ . . . .

PERMISSION: ____

____

____

____

INTRODUCTION: My name is ________________ ________________ and I

____

____

____

INTEREST: ____

____

____

____

____

CLOSE: ____

____

____

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PARTS OF THE BUSINESS LETTER

1.	**LETTERHEAD:**	On business correspondence, this is printed at the top of the page. Letterhead paper is only used for the first page of a letter.
2.	**DATELINE:**	Type the date in Month-Day-Year format a few lines below the letterhead. If non-letterhead paper is used, space down appropriately. No specific number of lines is given because the length of letters varies and this varies the spacing of the letter on the page to keep the top and bottom margins looking even.
3.	**INSIDE ADDRESS:**	Type the address of the person to whom the letter is being sent to just as it will appear on the envelope. Space down two lines for the salutation.
4.	**SALUTATION:**	Use the person's name whenever it is known. When you do not know the person's name, you should use his/her title. "Dear Sir,""Dear Madam," and "Gentlemen" are acceptable, but considered extremely formal. Space down two lines to the body of the letter.
5.	**BODY:**	This is the actual message being sent. Remember to keep the paragraphs about the same size so the letter looks pleasing to the eye. Also make sure that the content of one paragraph bridges well to the next. Space down two lines.
6.	**COMPLIMENTARY CLOSE:**	This is the polite, formal way to end a letter. The common complimentary closes used are: "Yours truly," "Truly yours," "Sincerely yours," and "Respectfully yours."
7.	**SIGNER'S IDENTIFICATION:**	This is typed four lines below the complimentary close in order to leave space for your signature. This should include the signer's name and any appropriate title.
8.	**REFERENCE INITIALS:**	The rule is to type the signer's initials in capitals, followed by a slash or colon, followed by the initials of the person who typed the letter in lower case. Space 1 line.
9.	**ENCLOSURE:**	The word "enclosure" or "enclosures" followed by a list of items, is added to make sure the reader does not overlook important papers in the envelope. Space 1 line.
10.	**"cc" NOTATION:**	This is a courtesy. It tells the reader who has been sent a carbon copy of the letter.

AGENCIES

There are three kinds of employment agencies: those that charge the employer a fee, those that charge the applicant a fee, and non-profit agencies.

Agencies that charge the employer a fee are paid a percentage of the first year's salary after the applicant is hired. You'll see this kind in the Yellow Pages by phrases like "100% employer financed.: If in doubt, ask on the phone before visiting the agency. These firms are hired by employers to obtain specific skills and talents. It costs you nothing--if reputable. It only costs the time to make the trip and register. It can be a good investment of effort.

Agencies that charge the applicant a fee usually charge a one-time up-front fee with no guarantee of employment. If an ethical agency can find a job for you and save you a month's hunting, it is worth the price, even a month's salary. BUT you want a reputable agency. Become cautious if the contract specifies a fee at both ends - a "registration" and then a "finder's" or "location" fee after the agency has found you a position. This may be all right, but it usually indicated the agency is working both ends against the middle. Check the agency's credentials with the Better Business Bureau, large employers, and friends. And do this obviously before you approach them.

Non-profit agencies are maintained in most large communities and are funded by the government or contributions from community efforts resulting in no cost to the applicant. The Illinois Job Service is an example of a non-profit agencies that can be contacted through the local Chamber of Commerce or the phone book.

Four types of agencies that will be discussed in terms of their objectives and areas of service are Professional, Clerical, Executive, and Temporary agencies. When seeking assistance from an employment agency, it is advisable to utilize those agencies that provide the types of employment opportunities that best suit the applicant.

Professional employment agencies function to fill positions such as engineers and computer programmers. These agencies have positions that are currently available in the job market. Many companies prefer to use professional employment agencies over advertising for their current needs. They offer a mutual exchange of information prior to your interview with the client firm.

AGENCIES
(continued)

Clerical/Administrative agencies are numerous and operate on a fee and a non-fee basis to the applicant. These agencies provide specialized employment services. In addition to job referrals, services to the applicant can include vocational counseling and assistance in preparing a resume. These agencies are advertised in newspapers and can be found in the Yellow Pages of your phone book under employment, employment agencies, employment services, and personnel consultants.

Executive Recruiting firms or agencies operate to fill the need for persons with proven managerial ability and experience. These firms are the "Tiffany's" of the employment business. By means of personal inquiries, personal contacts and selective advertising, firms that specialize in executive recruitment locate qualified executive candidates. They only deal in high caliber people and at breath-taking costs. While these agencies are not as numerous and may even specialize by industry, they are paid by the employer, not the applicant. They can be found in the Yellow Pages under employment, employment agencies, or personnel consultants.

Temporary agencies usually operate on a non-fee basis to the applicant. These agencies provide a good source of personnel to employers during peak periods, reducing layoffs during slow periods. They work with all fields including technical, administrative and clerical. By working with a temporary agency, an applicant can gain valuable work experience leading to permanent employment.

CLASSIFIED ADVERTISING

One of the quickest and most effective ways to find out about positions available in the local area is through the classified section of the daily newspaper. A recent survey conducted by the U.S. Department of Labor indicated that 60 percent of employers polled reported that they hired through classified advertising. The Sunday edition is usually your best source because it provides the advertiser with greater circulation. Other sources of recruitment ads will be covered later.

When reading the "help wanted" advertising section of a newspaper, it is more productive to read the entire page and mark each ad that is of interest to you. Looking at the entire page also gives you the opportunity to study the job market in your community. Cut out every ad that you plan to answer. This will help you to keep accurate records of your correspondence.

How To Read Ads

A primary objective of an advertisement is to provide applicants with important details about the company and the job. It describes the qualifications, level of experience, job title, kind of company and potential of the position. Some positions include information about starting salary and company benefits.

Career opportunities may appear under more than one classification or heading. Ads are listed alphabetically by job title in the classified section. The "key" is designed to help you focus on a particular area such as Accounting, Factory, or Sales. It is important to note, however, that some positions may be classified under several headings. For example, Accounting positions can be found under other headings such as Tax, Payroll, or Finance.

Selecting Ads

When responding to advertisements, it is important that you do not restrict your replies to those where you do not meet the "exact" qualifications. Most ads represent the qualifications for the "ideal" candidate. Exact matches are uncommon and the employer may modify the requirements if other skills are demonstrated or future potential exists. This is usually common when specific years of experience or background in the industry are required.

A large percentage of advertisements are classified as "blind" ads. These are ads which do not identify the advertiser. Blind ads are placed for many reasons. A company can avoid responding to applicants, a firm could gauge the market or maintain confidentiality among employees. An important point about blind ads is that they get only 50 to 60 percent as many responses as open ads. Therefore, your competition is cut in half. However, if you are currently employed, you should exercise caution. Try not to apply to a subsidiary, division, or parent of your company since this could jeopardize your present position. To increase your chances of success when responding to an ad, it is important to use a cover letter. The cover letter is a convention of the business world and represents proper business correspondence. An individualized cover letter allows you to target a particular company or position and helps you to distinguish yourself and your qualifications from the competition. It can also help you highlight specific areas of your education and experience as it relates to the position.

Since some ads may draw a large number of applicants, it is suggested that you time your response to arrive 2-3 days after the position is first advertised. This may allow your resume to be reviewed separate from the bulk of responses received earlier in the week.

Respond to as many appropriate ads as you can. To make a good first impression, be sure that the information you provide is timely and error-free. You may need to allow a few weeks for the company to review information from your resume and others. If you have not been contacted by the company after three weeks, you should contact the company concerning the status of the position and document the response for your records.

Information about salary requirements or salary history should be omitted from your resume and cover letter. This often causes many applicants to be screened out for earning too much or, in some cases, too little. Submit this information only if insisted upon by the company.

Where To Locate Ads

There are a variety of sources which the media in the U.S. use to regularly advertise positions. These include the Sunday editions of the New York Times, the Los Angeles Times and the Chicago Tribune, as well as all four regional editions of the Wall Street Journal. The Mart section of the Journal has a large recruitment section, especially in the Tuesday edition. Each region is consolidated in a weekly magazine called National Business Employment Weekly. You should also check industry trade magazines and publications from organizations who specialize in your occupational field. Since most of these advertisements can be found in many public libraries, it is highly recommended that you consult with your local librarian regarding availability of the materials. This is also more cost effective than having to subscribe to each publication. The library is clearly the best source for securing information.

Careful attention must always be given when responding to advertisements since this is an important part of the job search process. So remember, the key points are:

1. Read the Sunday edition and specialized papers on a regular basis.
2. Keep a record of all ads you respond to.
3. Do not worry about having the "exact" qualifications.
4. Always use an individualized cover letter.
5. Make a good first impression.
6. Follow up.

REFERENCES AND DIRECTORIES

When unemployment occurs, one source that is continually overlooked is the library. Whether it is your neighborhood library or college library, this is a great source to gather important information about companies which might have potential job openings.

The first step when you enter the library is to check and see if there is a reference section. If there is a reference section, that is the place you need to be.

The reference section will have various business directories and periodicals which will give you information about companies throughout the country. This information varies depending on the publication you select.

Business directories are used to find basic data on a company, organization, or individual. Some simply list a company's address, phone number, and chief office, while others provide a brief history, number of employees, sales figures, and background information on the company.

Consultants & Consulting Organizations Directory

Gale Research Co. (Triennial)

Lists over 5,000 firms, giving top officers and type of service offered. Includes subject index of firms and alphabetical index of individuals.

Directory of Corporate Affiliations

National Register Publishing Co. (Annual)

Lists over 3,000 American Parent companies with their divisions, subsidiaries, and affiliates.

Dun & Bradstreet Million Dollar Directory

(Annual) 3 volumes

Lists over 120,000 companies in America with an indicated worth of $1 million or more. For each it gives officers, products or services, SIC number, approximate sales, and number of employees. Includes various indexes.

Federal Jobs

(Bi-weekly)

This newspaper comes out bi-weekly listing all federal job openings. It lists total number of job openings for the publication, qualifications of each position, starting salary, and where to apply for the positions.

Moody's Manuals

(Annual) 7 volumes

Each manual deals with difference topics. The topics are:

1. Moody Industrial Manual
2. Moody Public Utility
3. Moody OTC Industrial Manual
4. Moody News Reports
5. Moody Municipal and Government
6. Moody Transportation
7. Moody Banking and Finance

These manuals cover capital structure, history of the company, business and properties, management, statistics, income accounts, balance sheets, financial and operating data, and long-term debts.

Standard & Poor's Register of Corporation Directors & Executives

(Annual) 3 volumes

Volume 1 lists over 36,000 U.S. and Canadian companies, and for each gives offices, type of business, SIC number, service range, and number of employees. Volume 2 lists executives and directors, with brief data about each. Volume 3 contains various indexes and lists.

Thomas Register of American Manufacturers

(Annual) Multi-volume

Volumes 1-11 list manufacturers by specific product. Volumes 12-13 list companies alphabetically, giving the address, subsidiaries, products, assets, and principal officers. Volumes 14-19 are "Catalogs of Companies."

LOCAL DIRECTORIES

Becker Guide (First Chicago Guide)

(Annual)

A guide to 245 publicly held corporations and major financial institutions in the Chicago and northern Illinois area.

Business Directory - Lake County

(Annual)

Goods and services available in Lake County are arranged by category. There are also alphabetical and SIC code indexes to companies.

Certified List of Domestic & Foreign Corporations

(Annual)

A list of corporations that do business in Illinois complied by the Secretary of State. Addresses and brief corporate information are provided.

Chicago, Cook County & Illinois Industrial Directory

(Annual)

Lists firms by name, product and location.

Illinois Manufacturer's Directory

(Annual)

Lists approximately 27,000 manufacturers by either product and process or geographic location. Information includes address and phone number, top executives, type of business, number of employees, and sales figures.

Illinois Services Directory

(Annual)

A companion volume to the previous directory for non-manufacturing industries. State manufacturing/ industrial directories are also available for Wisconsin, Michigan and Indiana.

Periodicals are a primary source of information on current trends and events in the business field. Articles in journals and newspapers can be found in the indexes listed below. For a magazine title that the library does not have, a reprint of the article can be ordered.

GENERAL PERIODICALS ARE
Indexes:

Business Periodicals Index, 1968-

A cumulative index to English language business periodicals arranged by subject, author and company name.

Chicago Tribune Index, 1972-

A monthly index to articles and personal names.

Magazine Index

A microfilm index to more than 400 popular periodicals covering the last 5 years.

New York Times Index, 1969-

A subject index to the newspaper which often includes a brief synopsis of the articles.

Predicast's F & S Index United States, 1981-

A quarterly index to articles from over 750 financial publications. Articles cover company, product, and industry information.

EMPLOYMENT APPRAISAL

For each position you have held, complete one of the following forms. Use a separate form for every position. Please begin with your most recent position and work backwards. Number each position also, as this will assist you later.

Company name:____

Division:____

Company address:____

Name and Title of Superior:________________________________
____

Dates of Employment: Start Date__________ End____________________

Reason for Accepting Position:_____________________________
____
____
____

Primary Responsibilities:__________________________________
____
____
____

Secondary Responsibilities:________________________________
____
____
____

Significant Contributions:__________________________________
____
____
____
____
____

Products, Services, Materials or Clients you worked with or know about:____
____
____
____

Reasons for Leaving the Position:__________________________
____
____
____

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EDUCATION AND TRAINING

Listed below are several questions regarding your past education and training. Please answer the following six questions with complete and accurate information. Check dates with schools if necessary.

1. List below your formal education, showing all degrees, certifications and honors. Give school names and dates attended. Begin with the most recent.

2. List all additional training. Include those sponsored by your company, past employers, associations, military, seminars, etc.

3. What have you studied informally on your own?

4. List below any professional, governmental, business or community organizations to which you belong.

5. Office equipment or machines on which you have been trained.

6. Special skills and abilities such as foreign languages, money-making hobbies, manual skills, and special interests.

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THE STANDARD RESUME

Your Full Name
Street Address
City, State, Zip Code
Phone Numbers - Home/Business

KNOWLEDGE OF OR EXPERIENCE WITH - or - PROFESSIONAL SUMMARY:	This section should state in bold, simple words what you know and/or can do. Use professional "Buzz Words," which can be found in position listing or advertisements. This section is meant to get the attention of the reader, to ATTRACT his/her attention, and get him/her to read further. It should tell the employer important information at a glance.
EDUCATION: ___/____ to ___/____	Begin with most recent: College, University or High School City, State List: Degree, major, and date of graduation. You may wish to include publications, honors, and grade point average.
PROFESSIONAL EXPERIENCE: ____/_____ to ____/_____	Company Name City, State Position:____________________________

The following paragraph(s) should portray a full range of your responsibilities and authority, listed in chronological order, with your most recent or present position first.

These paragraph(s) are extremely important and should answer the following questions:

1. What are your primary responsibilities?
2. Did you supervise a staff? How many and what type of work did they do?
3. Did you have customer or client contact?
4. What special projects were you involved in?
5. What financial responsibilities did you assume, i.e., budgets, forecasting, collection of funds?
6. Any administrative skills?
7. Any additional duties?

THE STANDARD RESUME

Your Full Name
Street Address
City, State, Zip Code
Phone Numbers - Home/Business

KNOWLEDGE OF OR EXPERIENCE WITH - or - PROFESSIONAL SUMMARY:	This section should state in bold, simple words what you know and/or can do. Use professional "Buzz Words," which can be found in position listing or advertisements. This section is to meant to get the attention of the reader, to get the attention of the reader, to ATTRACT his/her attention, and get him/her to read further. It should tell the employer important information at a glance.
EDUCATION: ___/____ to ___/____	Begin with most recent: College, University or High School City, State List: Degree, major, and date of graduation. You may wish to include publications, honors, and grade point average.
PROFESSIONAL EXPERIENCE: ____/_____ to ____/_____	Company Name City, State Position:____________________________________

The following paragraph(s) should portray a full range of your responsibilities and authority, listed in chronological order, with your most recent or present position first.

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2. Did you supervise a staff? How many and what type of work did they do?
3. Did you have customer or client contact?
4. What special projects were you involved in?
5. What financial responsibilities did you assume, i.e., budgets, forecasting, collection of funds?
6. Any administrative skills?
7. Any additional duties?

RELATED ACTIVITIES:	This section is optional. Additional skills, professional organizations or community activities.
REFERENCES:	Available upon request.

RESUME WORKSHEET

____
____
____
____

KNOWLEDGE OF AND EXPERIENCE WITH ______________________________

EDUCATION: ______________________________
_____/_____ ______________________________
_____/_____ ______________________________

PROFESSIONAL EXPERIENCE:
___/___ to ___/___ POSITION: ______________________________
RESPONSIBILITIES INCLUDE: ______________________________

___/___ to ___/___ POSITION: ______________________________
RESPONSIBILITIES INCLUDE: ______________________________

RELATED ACTIVITIES ______________________________

REFERENCES: ______________________________
Do NOT list, type "Available upon request"

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FREQUENTLY MISSPELLED WORDS

They can hurt you and the results from even the best letters. Always proof your letters before mailing!

absence
accidentally
accommodate
accompanying
achievement
acknowledgment
acquaintance
acquiesce
acquisition
across
adjacent
advantageous
aging
aisle
Albuquerque
all right
alleged
amortize
analysis
analyze
answer
apparently
approximate
arbitrary
architect
argument
assistance
attorney
autumn
auxiliary
bachelor
bankruptcy
basically
beginning
believe
beneficiary
benefited
Berkeley
biased
boundary
breakfast
buses
busy
calendar
campaign
carriage
catalog
category
cemetery
canceled
chaise lounge
changeable
chronological
Cincinnati
coincidence
collateral
colonel
colossal
column
commitment
committee
comparison
concede
conscience
conscientious
conscious
consensus
continuous
controversy
criticism
debt
debtor
defense
deficit
definite
dependent
Des Moines
descendant
describe
detrimental
develop
development
dilemma
disappoint
dissatisfied
dissimilar
double
ecstasy
eighth
eligible
eliminate
embarrass
emphasize
empty
enumerate
exaggerate
exceed
exercise
exhaustible
environment
exhibition
existence
exorbitant
experience
extension
extraordinary
facsimile
familiar
fascinating
February
forbade
foreign
foresee
forfeit
forty
fourteen
fourth
fulfil
gauge
government
grammar
grateful
guarantee
guardian
harass
height
hemorrhage
hors d'oeuvre
hygiene
hypocrisy
inasmuch as
incidentally
innocuous
innovation
inoculate
insistence
irrelevant
itinerary
judgment
labeled
laboratory
leisure
liable
liaison
library
lieutenant
lightning
likable
liquefy
license

FREQUENTLY MISSPELLED WORDS
(continued)

lose
maintenance
maneuver
marriage
mileage
miniature
minutiae
misapprehension
miscellaneous
mischievous
misspell
mortgage
necessary
negotiate
neither
nickel
ninety
ninth
noticeable
occasionally
occurrence
offense
offered
omelet
omission
oneself
opinion
pamphlet
panicky
parallel
partially
pastime
patience
permissible
perseverance
persuade
phase
phenomenal
physician
picnicking
Pittsburgh
plausible
possessions
practically
preceding
preferable
prerogative
presumptuous
pretense
privilege
procedure
proceed
programmed
prohibition
pronunciation
psychiatric
psychological
publicly
pursue
quantity
questionnaire
queue
receipt
receive
recipient
recommend
recruit
reference
relevant
renowned
rescind
resistance
restaurant
resume
rhythm
salable
schedule
seize
separate
sergeant
siege
similar
simultaneous
sincerely
sizeable
skillful
specimen
sponsor
strength
subpoena
subtlety
subtly
suing
San Francisco
summary
superintendent
supersede
surgeon
surprise
surveillance
susceptible
technique
temperature
tempt
theater
their
thoroughly
threshold
through
totaled
tragedy
transferred
traveler
unforgettable
unmanageable
unwieldy
usage
victim
warehouse
Wednesday
weird
whether
whiskey
wholly
wield
woolly
yield

SUGGESTED ACTION VERBS FOR RESUME WRITING

- Accountable
- Administer
- Arrange
- Assist
- Audit
- Balance
- Calculate
- Coordinate
- Create
- Design
- Develop
- Direct
- Educate
- Evaluate
- Execute
- Expand
- Fill
- Complete
- Generate
- Guide
- Help
- Initiate
- Instruct
- Investigate
- Lead
- Maintain
- Manage
- Negotiate
- Organize
- Prepare
- Process
- Produce
- Represent
- Responsible
- Revamp
- Revise
- Schedule
- Select
- Solve
- Source
- Study
- Supervise
- Teach
- Train
- Transfer
- Type
- Update
- Verify
- Write

FINAL CHECKPOINTS

HOW DOES IT LOOK?

Neatly typed and only on one side of the page?
Professionally reproduced?
Are important items underlined or capitalized?
Is it balanced (too much type and not enough space)?
Too many splotches?
Good quality paper?

HOW IS IT ORGANIZED?

Are your name, address, and phone numbers at the top of the first page? Are things listed by having the most recent items first (education, work)?
Are your headings and experiences grouped together so there is no confusion?

WHAT IS IN YOUR RESUME?

Are your latest employment experiences more detailed than previous ones?
Have you emphasized positive aspects of your experiences and what you have accomplished?
Does your education include other items such as degrees and honors?
Have you left everything on an open level rather than restricting yourself?
Have you taken out any unnecessary items that are not related to your experiences or are negative?
Are there any military honors or services that should be included?
Have you stressed leadership roles both in the business world and in the community setting?
Have you sold yourself and your abilities in your resume?
Have you indicated that excellent references of all types can be furnished?

HOW IS IT WRITTEN?

Is it grammatically correct?
Does it make sense to you and is it comfortable to read?
is everything spelled correctly and is punctuation correct?
Is it too wordy and tedious?
Are you specific and not using general statements?
Are there numerous action verbs that stress accomplishments and goals?
Is it natural sounding and original?

REFERENCES WORKSHEET

Personal

	Name	Address	Telephone
1.			
2.			
3.			

Business

	Name	Title	Company	Address	Telephone
1.					
2.					
3.					

Academic

	Name	Title	Institution	Address	Telephone
1.					
2.					
3.					

THE COVER LETTER
(Letter of Application)

When you mail your resume, it should be accompanied by a cover letter. The letter introduces you, says what you want, and asks for an answer. It must stand out from many other cover letters received. It must reflect you and your personality. It must be to the point and excite the employer's interest so he/she will want to meet you.

The cover letter usually includes the following:

1. Identification of the position you are applying for and how you learned of it.
2. Indication of why your unique qualifications caused you to apply for this particular position.
3. Reference to the reader to examine your enclosed resume.
4. Request for the next step in the employment process--a personal interview, an answer to your letter, etc.

Suggestions for writing a good cover letter:

1. Type each letter individually.
2. Address each employer by name and title.
3. Be brief. No more than one page.
4. State a specific job, not any job.
5. Be yourself. Don't copy or use someone else's letter.
6. Be sincere. State facts.
7. Reflect personal confidence to do the job.
8. Your cover letter should relate to or enhance your enclosed resume. It can enhance a general resume by highlighting certain qualifications.
9. Ask for an interview, and make it easy to set one up.
10. Make sure the employer knows how and where you can be contacted.
11. Post your letter so it arrives on a Tuesday, Wednesday, or Thursday when most offices are less busy.
12. Try to call within two days of your letter's arrival to ask for an interview.

SAMPLE COVER LETTER 1

307 Peachgate Lane
Glenview, IL 60035
(312) 555-8787

June 17, 1989

Mr. Joseph Hall
Executive Recruiter
First Main Bank
200 South Grand
Chicago, Illinois 60670

Dear Mr. Hall:

As president of a Human Resources professional organization, I am often in contact with other professionals in this field. At a recent meeting of our organization, I heard about the innovative developments and subsequent reorganization at The First Main Bank.

I am currently exploring other career options in the Human Resources field. My background includes career development, recruitment and selection, objective setting, and performance appraisals, implementation or reorganization strategies, and training and development. I have attached my resume which covers these and other areas in more detail.

After you have had an opportunity to review my background, I will be in touch with you. I would like to discuss any current or future staffing needs at the bank in the Human Resources area. I am looking forward to talking with you.

Sincerely,

Mary Davis

Enclosure

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SAMPLE COVER LETTER 2

307 Peachgate Lane
Glenview, IL 60035
(312) 555-8787

June 17, 1989

First Main Bank
200 South Grand
Professional Employment Unit 1-22
Chicago, Illinois 60670

Attention: J. Hall

I am submitting my qualifications for your consideration for the position of product manager as advertised in the Wall Street Journal, dated June 17, 1989, or equivalent opportunities.

I have had 15 years of hands-on experience in manufacturing, business and financial planning, plant and business acquisitions, and marketing strategy analysis. I am considering a change of field and would like to evaluate the contributions I can make in a banking environment.

I look forward to the opportunity to meet with you to discuss the possibility of various positions in your bank.

Sincerely yours,

Mary Davis

Enclosure

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COVER LETTER FORMAT

____
Street Address
____
City, State
____
Phone Number

____
Date

____________________ Person's Name
____________________ Person's Title
____________________ Company Name
____________________ City, State

Dear _______________: Name

(Purpose)

____
____
____
(Background/Refer to Resume)

____
____

____
(Ask for Interview, Telephone, Thank You)

____
____
____
Complimentary Close,

Your Name

Enclosure

smw.36

SAMPLE COVER LETTER 3

307 Peachgate Lane
Glenview, Il 60035
(312) 555-8787

June 17, 1989

Mr. Joseph Hall
First Main Bank
200 South Grand
Suite 0461
Chicago, IL 60670

Dear Mr. Hall:

My education and desire to pursue a career in finance has led me to seek the opportunity to meet with you and discuss the possibilities for a position with your organization. I am extremely interested in the areas of capital markets, credit/middle market, international credit and letters of credit.

My primary assets include strong interpersonal qualities, determination and an open-mind toward learning and development.

I believe First Main Bank, as a leading force within the industry, offers a great challenge to develop a multifaceted financial career.

Enclosed is a resume describing my educational and employment experiences which will perhaps be of some interest to you. I will be available to meet with you at your earliest convenience.

I look forward to hearing from you.

Sincerely,

Mary Davis

Enclosure

smw.37

SAMPLE COVER LETTER 4

327 Peachgate Lane
Glenview, Il 60035
(312) 555-8787

June 17, 1989

Mr. Joseph Hall
Professional Recruiter
The First Main Bank
200 South Grand
Chicago, Il 60670

Dear Mr. Hall:

During a recent phone conversation with Tom Smith in the Retail Banking Department, he suggested that you would be the appropriate person to receive a copy of my resume. I have enclosed a copy for your review for current openings in any of your retail customer service areas.

The enclosed resume outlines my solid work experience in customer service, in addition to the seminars and special training I have completed. I appreciate your time in reviewing it.

I look forward to hearing from you in the near future and hope that my skills and interest meet First Main's current needs.

Sincerely,

Mary Davis

Enclosure

smw.38

INTERVIEWS IN PROGRESS

DATE INTERVIEWED	COMPANY NAME	ADDRESS	PERSON INTERVIEWED WITH	INTERVIEW FOLLOW-UP OR OUTCOME
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

RESUMES SENT TO NEWSPAPER ADS

	DATE SENT	COMPANY NAME	RESUME SENT TO	JOB TITLE	INTERVIEW FOLLOW-UP OR OUTCOME
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

THE COMPANY FACT SHEET

The more you know about companies to which you are applying for a job, the more you can tailor a package (resume, cover letter, etc.) to catch the eye of the employer and create an interest in your skills and talents.

Use a form similar to that below for each company you will be contacting:

Company Name ______________________________

Address ______________________________

Phone Number ______________________________

Hiring Authority ______________________________

1. Company organizational structure?
2. Primary product or service?
3. Primary market area?
4. Company history?
5. Company prospects?
6. Compensation and benefits for the type of position I am interested in?
7. Training available?
8. Promotional policy?
9. Employment/labor history (hiring places, turnover, recent lay-offs)?
10. What are the skills, education, and experience requirements of the job I am interested in?
11. Contact person in the department I am interested in?
12. Contact person in the Personnel Office?

Sources of Information

1. Current and former employees
2. Competition in the same industry
3. Company Personnel Office
4. Company Annual Report
5. Library sources such as Standard & Poor's, Moody, etc.
6. Local Chamber of Commerce

smw.41

ORAL EXAM QUESTIONS AND ANSWERS

SAFETY Question 1. ____________________

A good answer would include: ____________________

Question 2. ____________________

A good answer would include: ____________________

Question 3. ____________________

A good answer would include: ____________________

MEASUREMENT

Question 1. ____________________

A good answer would include: ____________________

Question 2. ____________________

A good answer would include: ____________________

Question 3. ____________________

A good answer would include: ____________________

PRODUCT AND PROCESS CONTROL

Question 1.

A good answer would include:

Question 2.

A good answer would include:

Question 3.

A good answer would include:

QUALITY

Question 1.

A good answer would include:

Question 2.

A good answer would include:

Question 3.

A good answer would include:

BUSINESS ECONOMICS

Question 1.

A good answer would include:

Question 2.

A good answer would include:

Question 3.

A good answer would include:

smw.42

TEST QUESTIONS

Instructions: Write only one question for each area. Choose whichever type you want. You can have the same type for each area, or a different one for each, but write only one for each area.

SAFETY

Multiple Choice:

____
____
____

a. ______________________
b. ______________________
c. ______________________
d. ______________________

True/False:

____
____ T F

Fill in the blank:

________________ ________________ ______________________
____

Matching:

Word	Definition
______________________	_________________________

MEASUREMENT

Multiple Choice:

____
____
____

a. ______________________
b. ______________________
c. ______________________
d. ______________________

True/False:

____
____ T F

Fill in the blank:

________________ ________________ ______________________
____

Matching:

Word	Definition
______________________	_________________________

PRODUCT AND PROCESS CONTROL

Multiple Choice:

a.
b.
c.
d.

True/False:

T F

Fill in the blank:

Matching:

Word	Definition

QUALITY

Multiple Choice:

a.
b.
c.
d.

True/False:

T F

Fill in the blank:

Matching:

Word	Definition

BUSINESS ECONOMICS

Multiple Choice:

____

____

____

a. ______________

b. ______________

c. ______________

d. ______________

True/False:

____

______________________________ T F

Fill in the blank:

__________ __________ __________

____

Matching:

Word	Definition
______________	______________

smw.43

THE PROTOCOLS OF INTERVIEWING,
HANDOUT 1

DO:

1. Research the company prior to the interview
2. Research the job prior to the interview
3. Prepare questions for the interview
    - A. Ask questions about the JOB
    - B. Take samples of your work if applicable
4. Be prompt
    - A. Be there approximately 10-15 minutes early
    - B. Call if you are going to be late
5. Dress properly
    - A. Women
        - 1. Dress or skirt and blouse
        - 2. Business suit
    - B. Men
        - 1. Dress shirt and trousers
        - 2. Suit and tie
6. Drive by the company prior to the interview to ensure you know where you are going
7. Always go to an interview by yourself
8. Call if you need to reschedule or are cancelling the interview altogether
9. Fill out the application
    - A. Completely
    - B. Accurately
    - C. Use the sample application you completed before
    - D. Do NOT write "See Resume" on application
10. Read any available company materials (not magazines) while waiting for the interviewer to greet you
11. Be patient
    - A. Schedules are hard to stick to
12. Prepare yourself psychologically
13. Be nice to all persons you come in contact with
14. Always stand when introduced
15. Greet with a firm handshake
16. Always maintain good eye contact
17. If you want the job, let the interviewer know it
18. Follow-up letter
    - A. Send a note of thanks in your own hand writing immediately after the interview

smw.44

THE PROTOCOLS OF INTERVIEWING, HANDOUT 2

DON'T

1. Dress as if you were going out on the town
2. Wear jeans
3. Wear shorts/tee shirts
4. Wear tennis shoes
5. Bring along family, friends, or pets
6. Reschedule unless absolutely necessary
7. Chew gum
8. Smoke
9. Wear a hat, sunglasses, etc.
10. Fidget or move around in the chair
11. Send flowers, money, etc.
12. Send mailgrams, express mail
    A. A letter through the regular mail will do

WAYS APPLICANTS "STRIKE OUT" ON INTERVIEWS

Answers to a survey taken from companies who were questioned as to why an applicant, who is capable of doing the job, is not hired by them are given below (not in order of precedence).

1. Poor personal appearance
2. Lack of interest and enthusiasm - passive and indifferent
3. Overemphasis on money - interested only in the best dollar offer
4. Condemnation of past employers
5. Failure to look at the interviewer when conversing
6. Limp handshake
7. Unwillingness to go where sent
8. Late to interview
9. Failure to express appreciation for interviewer's time
10. Asks no questions about the job
11. Indefinite responses to questions
12. Overbearing, overaggressive, conceited, "know-it-all"
13. Inability to express self clearly - poor voice or grammar
14. Lack of confidence and poise - nervous, ill at ease
15. Lack of planning for career - no purpose or goals
16. Failure to participate in activities
17. Unwilling to start at the bottom - expects too much too soon
18. Makes excuses - evasive, hedges on hazy issues in work record
19. Lack of tact
20. Lack of manners, courtesy
21. Lack of vitality
22. Lack of maturity
23. Indecision
24. Sloppy application blank
25. Merely shopping around
26. Wants job only for a short time
27. No interest in company or industry
28. Cynical
29. Low moral standards
30. Lazy
31. Intolerant - strong prejudices
32. Narrow interests
33. Inability to take criticism
34. High-pressure type

DECISION-MAKING WORKSHEET

Reasons for Accepting	Reasons for Rejecting

- -

Name ______________________________

I (please circle the appropriate response) accept reject the offer of employment with ______________________________________

because ____

____

____

____

smw.47

QUALITY IN MANUFACTURING

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UNIT GOALS 3

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LIST OF FIGURES 4

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QUALITY.002	**Introduction to Statistics** . . . . An overview of the basics of statistics and how they relate to Quality Control. Students will be required to interpret tables, charts, and graphs.	12
QUALITY.003	**Preliminary Design Review** . . . . Students will be divided into several groups to prepare questions for a Preliminary Design Review; meeting to be chaired by the instructor.	27
QUALITY.004	**Product Qualification Tests** . . . . Students will be divided into groups, representing engineering, manufacturing, and quality control. Students will prepare for and participate in a meeting to establish the qualification criteria for a given product.	33
QUALITY.005	**Material Specifications** . . . . Students will be divided into teams to establish material specifications for Class 1--new product parts.	39
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QUALITY.009	**Packaging and Shipment Quality Control** . . Students will compete in groups for the best packaging of a particular product.	63
QUALITY.010	**Customer Satisfaction and Service** . . . . . A group activity designed to produce a set of guidelines or procedures for all employees to provide quality customer service and maximum customer satisfaction.	68
QUALITY.011	**Product Liability** . . . . A group activity in which everyone participates in a mock trial. A jury will be selected and verdict will be rendered.	75
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QUALITY.013	**Quality Cost Improvement Projects** . . . . . Group activity requiring students to develop a project for a specific product.	88

UNIT GOALS

1. Match modern manufacturing terminology with the correct definitions. (Quality.001)
2. Define "Quality in Manufacturing" and explain why it is important. (Quality.001, 002)
3. Conduct tests and reviews to ensure quality in product design. (Quality.003, .004)
4. Establish procedures for maintaining quality of incoming material and vendors. (Quality.005)
5. Define terms and phrases commonly associated with production quality control. (Quality.006)
6. Establish methods, plans, and procedures for maintaining quality at various points in the production process. (Quality.006, .007, .008)
7. Develop plans for packing and shipping quality control. (Quality.009).
8. Establish procedures for maintaining quality in customer service. (Quality.010)
9. Develop methods for measuring customer satisfaction. (Quality.010)
10. Simulate product liability legal actions. (Quality.011)
11. Establish procedures for handling complaints and claims for a given product and create a product recall plan. (Quality.012)
12. Evaluate data relative to quality costs. (Quality.013)
13. Develop a quality cost improvement project. (Quality.013)

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ACTIVITY NUMBER QUALITY.001

INTRODUCTION TO QUALITY TERMS AND CONCEPTS

Description:

This activity will give the student an overview of the importance of quality in manufacturing and a fundamental vocabulary for the world of quality control.

Rationale:

Two things are essential for success in manufacturing as our country moves into the 21st century: small lot sizes and excellent quality. Without quality, you'll soon be without business.

Outcomes:

The student will be able to define the term "quality" as it relates to a manufacturing environment and be able to define key manufacturing terms.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill.
2. Gitlow, H., & Gitlow, S. (1987). The Deming guide to quality and competitive positions. Englewood Cliffs, NJ: Prentice-Hall.
3. Peters, T. (1987). Thriving on chaos. New York: Knopf.
4. Schonberger, R. (1986). World class manufacturing. New York: Free Press.
5. Society of Manufacturing Engineers 1989 Catalog. (1989). Dearborn, MI: Author.

Instructional Strategies:

Instructor will lecture in depth on the importance of quality in all operations and specifically how it relates to modern manufacturing. Students will then read the information sheet provided and use it to complete the worksheet. The worksheet is a fill-in-the-blank and matching exercise. Serves as an introduction to the whole Quality section.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

_____ Assertiveness
_____ Negotiation
_____ Listening
_____ Risk Taking

Change:

_____ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications________________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
_____ Implementation

If you walk through any book store and look at the best seller list, peruse the articles in any leading business magazine, or look in the catalog of the Society of Manufacturing Engineers (SME), you will see books and articles relating to "Excellence" and "Quality." The message should be very clear to any observer of the manufacturing scene in the United States: "If you don't make a quality product and provide support for it, you're not going to be in business very long." The large number of publications currently giving advice on how to improve profits by improving quality is too long to list here, but some of the more prominent ones should be mentioned. If you are interested in making a career in manufacturing, you need to find out what these people are saying.

Tom Peters in **Thriving on Chaos** says that manufacturing must become a "source of quality, responsiveness, and innovation" Richard J. Schonberger in **World Class Manufacturing** says, "Quality is everyone's business." Armand V. Feigenbaum in **Total Quality Control** says, "Quality has become the single most important force leading to organizational success and company growth in national and international markets." Gitlow and Gitlow in **The Deming Guide to Quality and Competitive Position** say, "Foreign competitors have surpassed us by constantly improving their quality, while American quality has decreased." The quotes could go on and on and we would not touch the surface on the importance of "quality." And we can not forget quotes from people like Shigeo Shingo, Taiichi Ohno, and Dr. W. Edwards Deming. Today more than ever before, there is an abundance of printed, audio, and video material available to assist in improving the quality of any work environment.

What this information sheet should do is make you aware of some of the resources available to you in your study of quality and to give you a very basic introduction to modern quality terms, phrases, and definitions. Today is an age of high technology and continuing education. People will continue with training of some type long after they have completed their formal education. You are encouraged to seek out the resources listed in this unit, and use them to put more "tools" in your manufacturing "tool box."

Quality in manufacturing can be divided into five areas. First, there is quality in design which involves methods and procedures for insuring the quality of a product before it goes into production. The second area of quality is in production. Production quality consists of raw material inspection, in-process inspections and process control, and the disposal of nonconforming parts and materials. The third area of quality involves packaging and shipping the product. The fourth area of quality deals with service after the sale. This usually consists of customer service, product liability, claims, recalls, and complaints. The last area of quality deals with the factors involved with the cost of quality.

The cost of quality deals with analysis of both direct and indirect costs. Direct costs are associated with internal and external failures that can be directly controlled by the manufacturer. Indirect costs are those associated with customer dissatisfaction and loss of reputation. For all of these costs, data are collected, evaluated, and analyzed. The next step is to implement some type of Quality Cost Improvement project.

When you think of these five areas of quality, think about which departments they fit into in a manufacturing company. Design quality would fall into Design Engineering. Production quality would fall into Manufacturing or Production or both. Packaging and Shipping may be one department or could be divided into two. Quality after the sale would be the Customer Service department, and the cost of quality would probably be covered by the Accounting department. One department not mentioned is the Quality Assurance or Quality Control department. This department would have the appropriate people in it to coordinate quality activities with the previously mentioned departments.

QUALITY WORKSHEET 1

1. Why is quality important in the world of manufacturing today?

2. What are the five basic areas of quality in manufacturing?

3. Which department would deal with quality after the sale?

4. What are the differences between direct and indirect quality costs?

5. What are the three phases of production quality control?

Alternative Strategies for Activity Number: Quality.001

Provide students with magazine resources, such as the last six months of Time, Business Week, or Manufacturing Engineering, and have students research articles on the importance of quality in the world market place and report on their findings. Students should be divided into groups and assigned one category each (such as one group to Time, one to Business Week, etc.).

Learning/Performance Checks for Activity Number: Quality.001

Using the answer sheet provided below, evaluate each student's answers to **QUALITY WORKSHEET 1.**

1. The primary reason here should focus on being competitive in the "global" market.
2. The five basic areas of quality in manufacturing are: Design Quality, Production Quality, Packaging and Shipping Quality, Customer Service Quality, and Cost of Quality.
3. The Customer Service Department would deal with quality after the sale.
4. Direct costs are those which can be controlled by the manufacturer and indirect costs are those associated with loss of reputation and customer dissatisfaction.
5. The three phases of production quality control are: raw material inspection, in-process inspection and disposal of nonconforming material.

ACTIVITY NUMBER QUALITY.002

INTRODUCTION TO STATISTICS

Description:

This activity will overview the basics of statistics and how they relate to quality control. Students will be required to interpret tables, charts, and graphs.

Rationale:

Being able to record and analyze data relative to the quality of production is a fundamental prerequisite to implementing a successful quality program.

Outcomes:

Students will be able to analyze and interpret basic statistical data and utilize the terms associated with quality control.

Tools, Materials, Machines, and Resources:

1. Besterfield, D. (1986). Quality control (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.
2. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 343-607)

Instructional Strategies:

Instructor will use information sheets and lecture/demonstration to acquaint the students with the terminology, charts, tables, and graphs used in quality control. The intent here is NOT to make the students expert statisticians or even mathematicians, but to make them familiar with the basic terminology and tools they will find in a manufacturing environment. The students will then be asked to interpret charts and tables into meaningful information about a process and make decisions based on their analysis.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
_____ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

_____ Ethical Reasoning
__x__ Logical Reasoning
_____ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

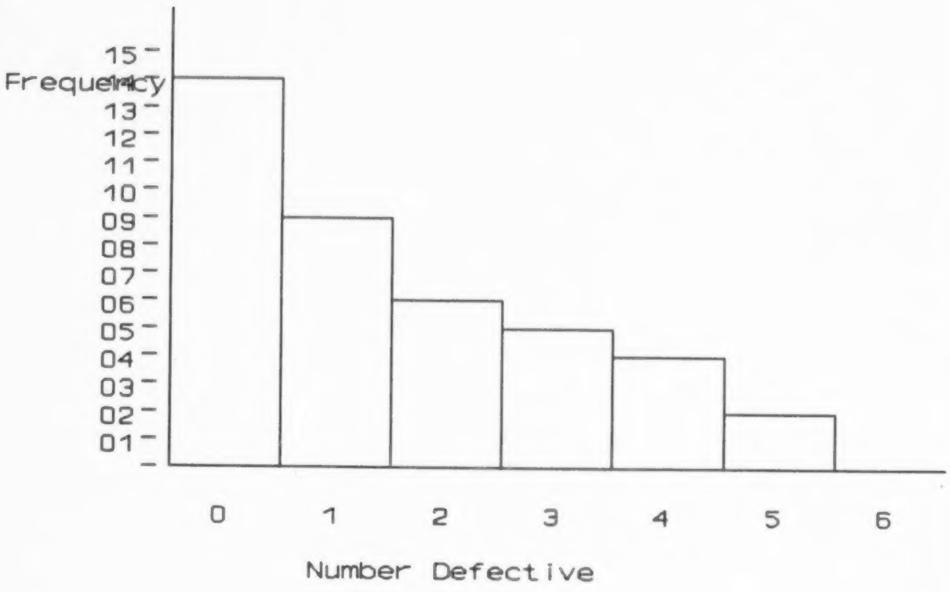
To be able to communicate in the world of quality control, you need to speak the language of quality control. One of the main elements of quality control language is statistics. Statistics is the science that deals with the collection, tabulation, analysis, interpretation, and presentation of quantitative (of, relating to, or expressible in terms of quantity) data. You encounter statistics every day and may not even realize it. Some examples are in sports (baseball, hockey, tennis), accident statistics around every holiday, and employment statistics whenever a company opens or closes its doors.

Put very simply, you can record data about almost any process and later analyze these data in order to try to adjust the process for improvement. An example might be recording how many attempts a person makes to score a goal or point in a game and also recording how many times he or she is successful. If you did this for every person on the team, you would then have statistics regarding their success. To effectively use these statistics though, you would probably need to gather more detailed data, such as what part of the game (inning or quarter), how far away from the goal they were, did they pitch/bat left-or right-handed, etc. The more information gathered, the better a decision could be made later, such as player A is successful 95% of the time when shooting left-handed within 10 feet of the goal, and only 30% successful when shooting right-handed within 10 feet of the goal. From this you might conclude that player A should only shoot left-handed when inside 10 feet. From this simple example, you should be able to see the value of statistics and some further definitions should make using statistics in manufacturing to improve quality easier to do.

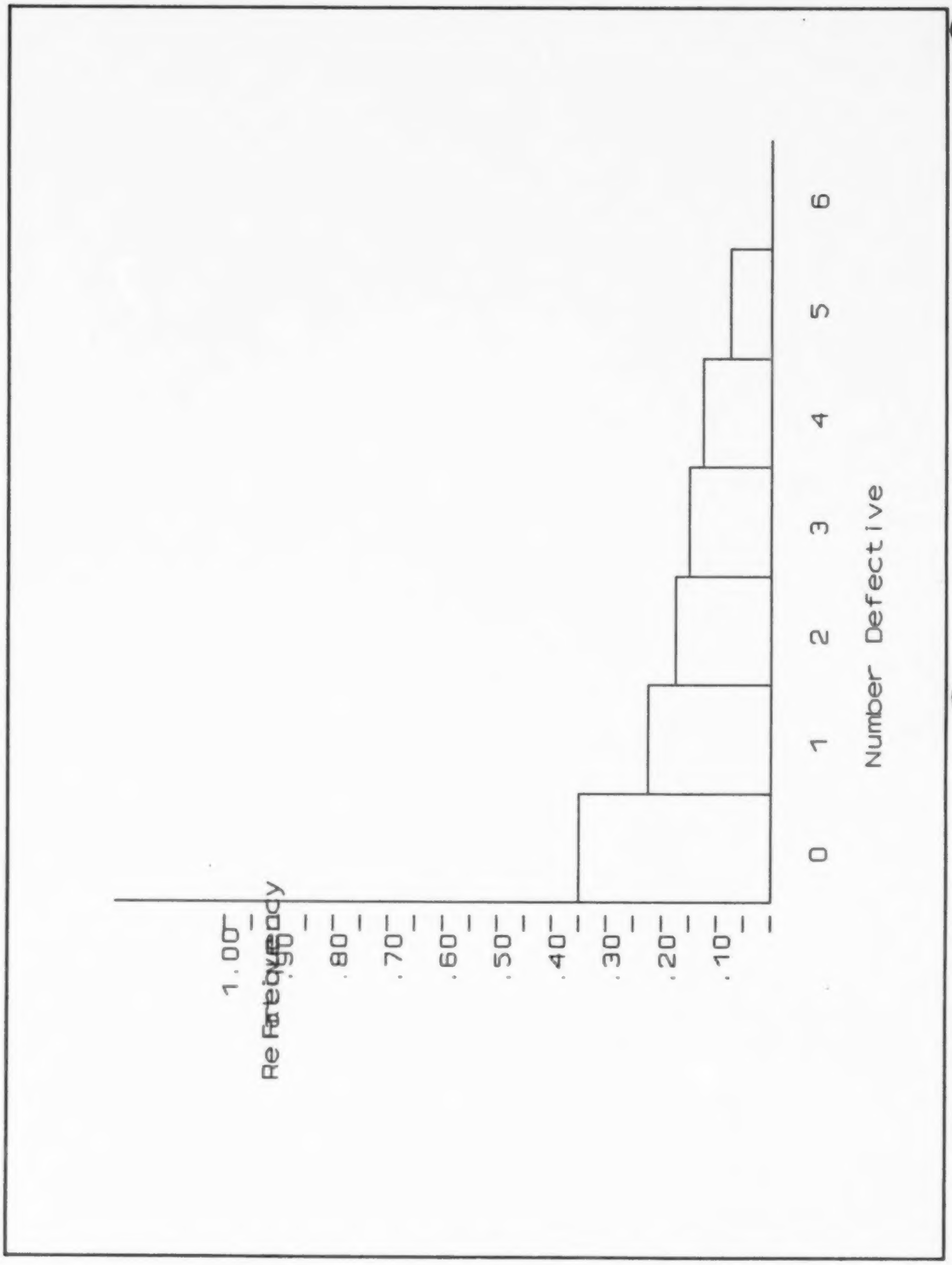
The purpose of this information sheet is to acquaint you with some of the tools used in statistics, NOT to make you a statistical expert. There are many good references and courses designed to make you an expert. Whenever data are collected, there are usually two techniques used to summarize the data and make it usable. One is graphical and the other is analytical.

The graphical technique is a plot of a frequency distribution. This is actually an arrangement of data to show the frequency of values in several categories. The analytical techniques present data by computing a measure of central tendency and a measure of dispersion.

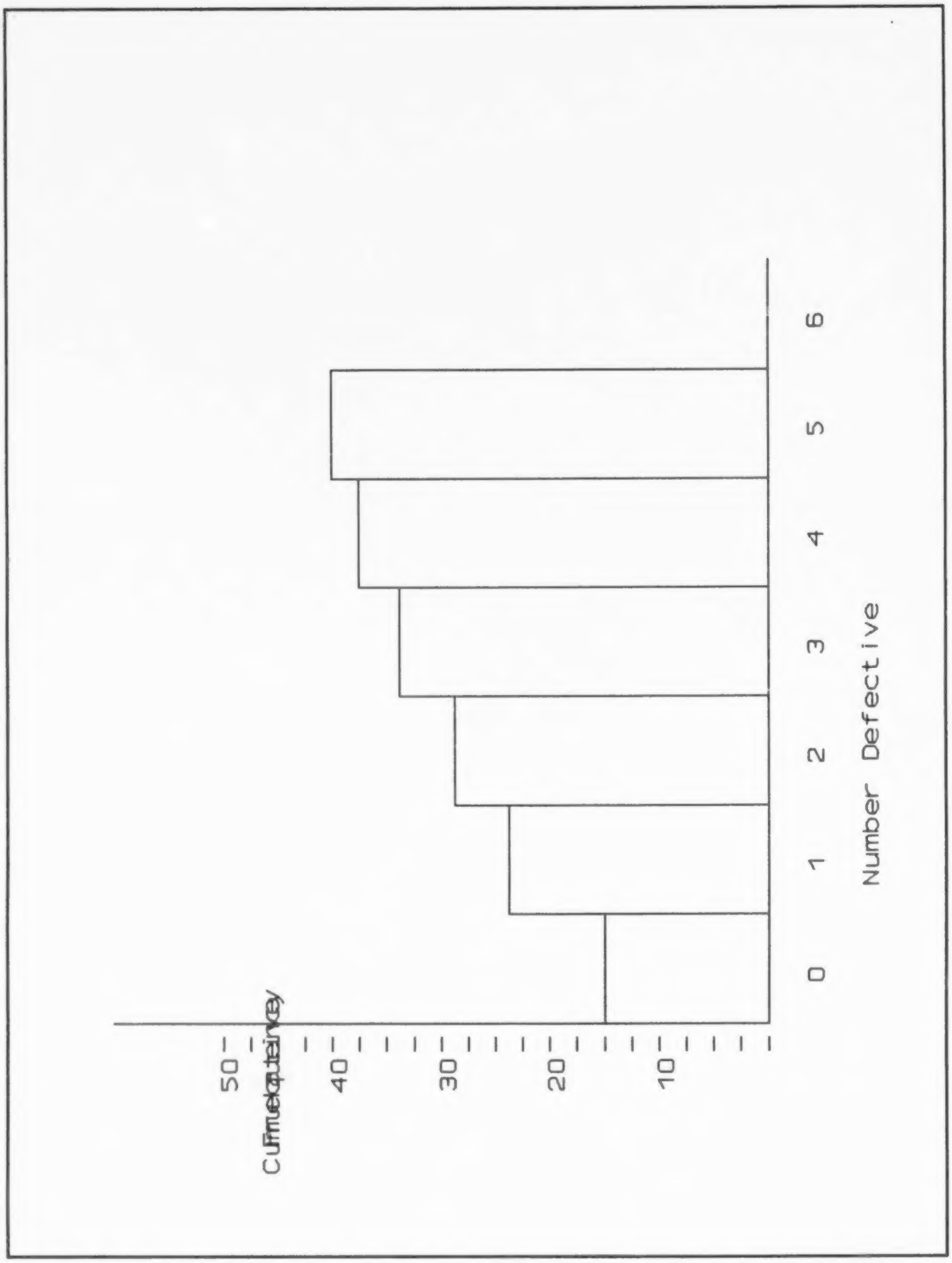
The frequency distribution uses several different plots or graphs to display data. The most common is probably the histogram. Histograms are found in four basic varieties: the frequency histogram, the relative frequency histogram, the cumulative frequency histogram, and the relative cumulative frequency histogram. Examples are shown in Quality.002/Fig. 1, Quality.002/Fig. 2, Quality.002/Fig. 3, and Quality.002/Fig. 4.



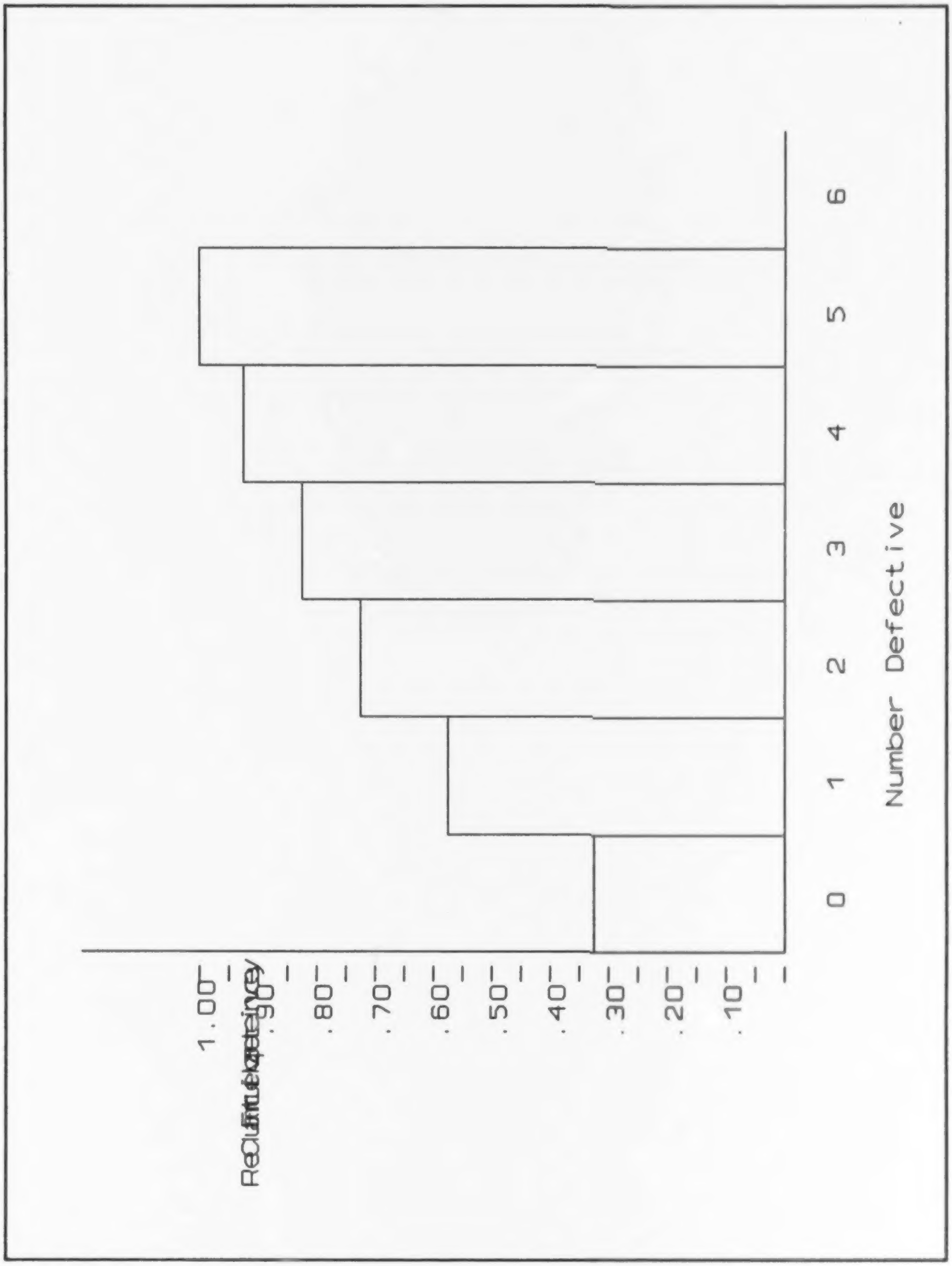
Quality.002/Fig. 1. Frequency Histogram
(QUALITY IN MANUFACTURING, Quality.002)



Quality.002/Fig. 2. Relative Frequency Histogram (QUALITY IN MANUFACTURING, Quality.002)



Quality.002/Fig. 3. Cumulative Frequency Histogram
(QUALITY IN MANUFACTURING, Quality.002)



Quality.002/Fig. 4. Relative Cumulative Frequency Histogram (QUALITY IN MANUFACTURING, Quality.002)

Suppose 40 lots of a certain product are inspected for defects. Regardless of the number of items in each lot, you might get results as shown in Quality.002/Table 1.

It is very difficult to get any useful information from these data (see Quality.002/Table 1, so the next step is to use Quality.002/Table 2.

Quality.002/Table 2 makes it easier to see that 14 lots had 0 defects, 9 lots had 1 defect, 6 lots had 2 defects, and so on. Quality.002/Table 3 represents the figures for each type of histogram and the histograms themselves follow with a brief explanation of each.

Using Quality.002/Table 3, four different histograms can be drawn. The histogram consists of a set of rectangles that represent the frequency in each category.

Table 1

Number of Defective Items in 48 Lots

0	1	2	3	4	5	0	0
1	0	2	0	0	3	4	0
1	2	3	4	5	0	0	0
1	1	2	2	3	0	0	4
3	0	2	1	1	1	0	1

Quality.002/Table 1. Number of Defective Items in 48 Lots
(QUALITY IN MANUFACTURING, Quality.002)

Table 2

Defective Item Breakdown

Defects	Tally from Table #1		Frequency
0	11111111111111		14
1	111111111	9	
2	111111	6	
3	11111	5	
4	1111	4	
5	11	2	

Quality.002/Table 2. Defective Item Breakdown
(QUALITY IN MANUFACTURING, Quality.002)

Table 3

Different Types of Frequency Distributions

Defects	Frequency	Relative Frequency	Cumulative Frequency	Relative Cumulative Frequency
0	14	14/40 = .35	0 + 14 =	14/40 = .35
1	9	9/40 = .23	14 + 9 =	23/40 = .58
2	6	6/40 = .15	23 + 6 = 29	29/40 = .73
3	5	5/40 = .12	29 + 5 = 34	34/40 = .85
4	4	4/40 = .10	34 + 4 = 38	38/40 = .95
5	2	2/40 = .05	38 + 2 = 40	40/40 = 1.00
Total	40	1.00		

Quality.002/Table 3. Different Types of Frequency Distributions
(QUALITY IN MANUFACTURING, Quality.002)

The Frequency Histogram (see Quality.002/Fig. 1) simply illustrates how many lots had zero defects, how many had one defect, how many had two defects and so on.

The Relative Frequency Histogram (see Quality.002/Fig. 2) provides a reference. It illustrates for example that 23% of the lots that were inspected had 1 defect, and only 5% of the lots inspected had 5 defects. The relative frequency is determined by dividing the frequency (number of lots with 1 defect) by the total (number of lots inspected).

The Cumulative Frequency Histogram (see Quality.002/Fig. 3) illustrates that 23 lots had 1 or less defective items. This is determined by adding the frequency of each to the previous total.

The Relative Cumulative Frequency Histogram (see Quality.002/Fig. 4) illustrates that 58% of the lots inspected had 1 or less defective items. This is determined by dividing the cumulative frequency by the total.

Another type of histogram is the Pareto distribution. It will be covered in detail in the activity on quality costs. Analytical techniques used to summarize data are the Measure of Central Tendency and the Measure of the Dispersion.

A Measure of Central Tendency for any distribution is a number that describes the central position of the data or how the data tend to build up in the center. There are three techniques used with a Measure of Central Tendency. They are: the average, the median, and the mode.

The average is the most common measure of central tendency. It is simply the sum of the observations, divided by the number of observations. In our previous example, 40 lots were inspected and 62 total defects were found._ The average would be 1.55 defects per lot. The average is written X and is read as "X bar."

The median is defined as the value which divides a series of ordered observations so that the number of items above it is equal to the number below it. If the number of items is odd, the median is the midpoint of the values (3, 4, 5, 6, 8, 8, and 10 has a median of 6). If the number of items is even, the median is the average of the two middle numbers. For our defects, if you order the numbers from Table 1, the median would be 1.

The mode of a set of numbers is that value which occurs with the greatest frequency. It is possible, for any set of numbers, to have either no mode or multiple modes. For our defects, the mode would be 0 because it occurs the greatest number of times.

The Measure of Dispersion describes how the data are spread out or scattered on each side of the central value. Both measures of central tendency and dispersion are usually used to describe a collection of data. Three things make up measures of dispersion: the range, the standard deviation, and the variance.

The range of a series of numbers is the difference between the largest and the smallest values or observations. In our example of defects, the range would be: R = High - Low or 5 = 5 - 0.

In quality control, the range is a very common measure of the dispersion. The primary advantage of the range is in providing a knowledge of the total spread of the data. It is the only measure of dispersion that is not a function of a measure of central tendency.

The standard deviation is used when a more precise measure is desired. It is also the most common measure of the dispersion for quality control work and is used when subsequent statistics are to be calculated. When the data have an extreme value for the high or the low, the standard deviation is more desirable than the range.

For application of the previous information, continue with **QUALITY WORKSHEET 2**.

QUALITY WORKSHEET 2

Using the information sheets and examples provided, students will be divided into groups and asked to analyze the data presented by various charts, graphs, and tables provided by the instructor. As a group, the students will then make manufacturing decisions based upon their data analysis.

Alternative Strategies for Activity Number: Quality.002

Have the students make some observations and record data. Then divide them into groups to plot graphs and histograms. After the histograms have been prepared, they should be analyzed and discussion groups used to draw conclusions. This could be something as simple as dividing the lunch period into short time frames and observing how many buy lunch or bring lunch, or what type of beverage people prefer. The objective would be to collect and analyze data and to draw conclusions.

Learning/Performance Checks for Activity Number: Quality.002

Students should be evaluated based upon their participation in groups and the decisions reached by the groups relative to the data provided.

ACTIVITY NUMBER QUALITY.003

PRELIMINARY DESIGN REVIEW

Description:

The class will be divided into several groups to prepare questions for a Preliminary Design Review meeting to be chaired by the instructor.

Rationale:

When design and manufacturing agree on a new product before it goes into production, the higher the quality the final product will be.

Outcomes:

Student will be able to conduct a Preliminary Design Review for a given product.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 65, 231, 615)

Instructional Strategies:

Instructor will provide initial product design data for a given product. Students will then be divided into several groups representing the complete manufacturing process and related departments. Each group will be charged with developing a set of questions for the meeting. After each group decides on a spokesperson, the instructor will chair the meeting using the agenda provided.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

[✓ Reading]
[✓ Writing]
[✓ Speaking]
[✓ Listening]

Computation:

Fractions
Decimals
Percents

Personal

Teamwork (Interpersonal):

[✓ Assertiveness]
[✓ Negotiation]
[✓ Listening]
[✓ Risk Taking]

Change:

[✓ Personal Adaption]
Professional Adaption

Computer:

Operating Systems
Keyboards
Applications

Decision Making:

[✓ Ethical Reasoning]
[✓ Logical Reasoning]
[✓ Flexibility]

Problem Analysis:

[✓ Identification]
[✓ Solutions]
[✓ Evaluation]
[✓ Implementation]

Design quality control involves the establishment and specification of the necessary cost-quality, performance-quality, safety-quality, and reliability-quality guidelines for the product's intended use and customer satisfaction. This includes the elimination or location of possible sources of quality troubles before the start of formal production.

There is a cycle for developing new designs and products within every company. There are four basic elements to design quality control programs. They are explained as follows.

First is the establishment of the quality requirements for the product. This involves conducting analyses that determine customer satisfaction-oriented specifications and standards. These standards include performance, reliability, maintainability, and safety requirements and the cost-quality balance for the product. It will also include that portion of the overall quality program which covers the preproduction evaluation and testing of the product.

Second is the design of a product which meets these requirements. This involves the establishment of detailed drawings for the product and preparation of the related engineering instructions. It includes following the quality program for classifying product and process characteristics, for conducting product life and safety evaluations, and for carrying out environmental and other tests to determine the reliability of components and subassemblies and of software when necessary. It also includes field tests and performance studies of assembled prototypes or hand-made samples. Simulation studies of product quality may be made where physical prototypes cannot be made available. Product cost, life cycle quality, and cost goals are evaluated.

The third element is planning to assure maintenance of the required quality. This involves the formal activation of the details of that portion of the quality program which covers the control of purchased material, the maintenance of quality during processing and production, and the assurance of quality during field installation and product servicing. It also includes the development of the final specifications for the quality information equipments which are required for incoming material, in-process control, and field testing and evaluation. The important part here is producing quality products through control of the process and not just filtering out bad parts through inspection.

The fourth element is the preproduction review of the new design and its manufacturing facilities and the formal release for active production. This involves the planned, formal evaluation of the designed product at several stages of the complete design process to assure its capability of meeting its warranties and guarantees under conditions of actual use. It also involves analyses of the capabilities of the processes which will be required to produce the product. A series of performance and product qualification tests will be conducted, in terms required by the quality program, to review the product in all important customer end-use aspects.

Particular emphasis is placed upon component testing under conditions which simulate actual customer use. These reliability tests also couple components into subassemblies to evaluate the effect of different combinations upon quality.

There are five basic steps in the design quality control program. First is the preliminary design review. After successful review, the preliminary testing and reliability phase is conducted. Next comes the intermediate design review, followed by the final design review. After all reviews are complete, the design goes into product qualification testing.

When the design has reached the preliminary design stage, a preliminary design review is held. This session is chaired by Engineering with close participation by Quality Control. It is attended by representatives from Production, Manufacturing, Engineering, Marketing, Purchasing, and Customer Service. The design engineer reviews the function, concept, and technology of the product, describes its operation, and points out those subassemblies and component parts which are likely to be critical to proper operation. Projected plans for the reliability and maintainability program for the product are reviewed. Safety and product-liability considerations are examined and action plans are established to assess the product design for these factors.

For this activity, students will be divided into groups and prepare for a Preliminary Design Review using **QUALITY WORKSHEET 3**.

QUALITY WORKSHEET 3

The class will be divided into seven groups: Design Engineering Quality Control, Production, Manufacturing, Engineering, Marketing, Purchasing, and Customer Service. For a given new product design, each group will prepare questions for a Preliminary Design Review meeting. Each group will decide on a spokesperson to represent them in the meeting. After questions have been decided on, the instructor, playing the role of engineering manager, will call the meeting to order and proceed with the following agenda:

Preliminary Design Review Agenda for ___________________

Opening remarks - Engineering

Design Team Considerations

Quality Control comments

Production Concerns

Manufacturing Concerns

Marketing Input

Purchasing Concerns

Customer Service Input

Closing Assignments and Recommendations

Alternative Strategies for Activity Number: Quality.003

Instead of having a meeting with all departments, divide the class into groups to represent only engineering, quality, and manufacturing. Then have each group prepare a list of questions regarding a given product's design. Evaluate the questions and use the best ones for a class discussion on whether or not to proceed with building and testing a prototype.

Learning/Performance Checks for Activity Number: Quality.003

Several class members should be assigned the duty of taking minutes for the meeting. They should be responsible for accurately listing all questions and answers raised by the group. They must also record the assignments and recommendations made by the group. Class members should be evaluated based upon their participation in the group process.

ACTIVITY NUMBER QUALITY.004

PRODUCT QUALIFICATION TESTS

Description:

The class will be divided into groups, representing engineering, manufacturing, and quality control. The people will meet to establish the qualification criteria for the given product. The purpose here is to complete the last design quality function before releasing the product for active production.

Rationale:

The step is necessary to prove that if specifications and drawings are followed, satisfactory product performance can be expected in the field.

Outcomes:

Students will be able to conduct Product Qualification tests on a given product.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill.

Instructional Strategies:

Instructor needs to use the provided information sheet to explain the importance of this step. Then the class will be divided into engineering and quality groups to determine if the product is to be released for production.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

To be effective, it is essential that the reliability program for a new design measure the reliability of the product at several steps in its development cycle. This makes it possible to know the potential reliability of the product design, the reliability of the product as it is produced by the production process, and the life expectancy of parts likely to wear out first in a product.

Much information is collected from a pilot run on the first production parts, and the statistical tools of quality control are put to use. Frequency distribution studies are made on the important aspects of the critical parts in the assembly. Such distributions reveal whether the manufacturing processes, in their present condition, will produce parts within the specified tolerances.

Quality Control is interested in frequency distribution analyses of parts from several points of view: sampling inspection of outside vendor parts, approval of molds, and so on. The design engineer's main interest in these analyses is measuring the overall functional performance of the product. After these studies have been completed, the product will go into qualification testing.

Product qualification testing involves a number of tests and will determine if a product is to be released for production runs. Some of the tests used are: Failure Mode, Effect, and Criticality Analysis of FMECA, a design maturity test, a process maturity test, life tests, and product safety tests.

Failure mode, effect, and criticality analysis (FMECA) is usually performed at the early stages of a new product design. What it does is examine all the ways in which a component failure may occur--partial failure, catastrophic failure, or wear out of each component. It is then the basis for review of action already taken or planned to compensate for such events. The mode of failure and the degree of user negligence are also considered.

The design maturity test measures the mean time between failures or MTBF for a new product before it is committed to volume production. Generally a failure is considered any malfunction that prohibits the product from performing according to its specification and especially anything that would require a Customer Service call. The MTBF may be an indicator of the residual design problems remaining in a product design. The test is usually conducted when the first prototypes have been completed and checked out to the design engineers' satisfaction. It is accomplished by functionally operating the test samples to simulate actual customer use for a prolonged period. As failures are observed, they are classified by their similarity (symptom, failure mode, time, and so on). Similar failures are then ranked in groups in decreasing order of frequency of occurrence. This helps to establish a priority for eliminating the causes.

The process maturity test is a burn-in test type. It is usually conducted on the initial production units for a pre-established amount of time. The purpose of this test is to make sure that the product design which was qualified by the design maturity test and the process which is to produce it are both now qualified.

The life test measures the life expectancy of components of a unit. The time to failure is measured on a number of samples so that the MTBF and the distribution of each observed failure mode can be determined. Life testing is performed after the product has demonstrated that the design is reliable as it is manufactured. The product will have already successfully completed the design and process maturity tests and be in controlled production.

While the above tests are being conducted, product safety testing, which was started during the FMECA testing, is completed for safety and product liability assurance. The purpose of these tests is to identify hazard sources and their possible interaction with users and the environment. This analysis permits an assessment of the frequency and the severity of possible injuries while taking into account the uses and possible abuses of the product. It also helps identify alternative component or end-product designs which might reduce injury risk.

For this activity, students will be divided into groups for completing **QUALITY WORKSHEET 4.**

QUALITY WORKSHEET 4

The class will be divided into groups representing Engineering, Manufacturing, and Quality Control. The Engineering group will develop guidelines for design maturity testing of a specific product. The Quality Control group will develop guidelines for accepting the results of the design maturity tests. The Manufacturing group will develop guidelines for practical application of Engineering and Quality Control recommendations. If time permits, the testing of an instructor-selected product should be conducted and be accepted or rejected by the quality team. The emphasis here should be on MTBF.

Alternative Strategies for Activity Number: Quality.004

Rather than developing guidelines and accepting or rejecting a product, the class could conduct a design maturity test on a selected product and determine both MTBF and basic FMECA.

Learning/Performance Checks for Activity Number: Quality.004

The instructor will evaluate all students based upon their participation in group and class discussions. Consideration must also be given to the group-established criteria for product qualification. The instructor is encouraged to guide the meeting toward completion, but not to lead the group to a specific ending. Let the students establish the criteria and if some criterion is incorrect or even missing, let that be covered in a critique session.

ACTIVITY NUMBER QUALITY.005

MATERIAL SPECIFICATIONS

Description:

Students will divide into teams to establish material specifications for Class 1, new product parts. Teams will be provided with guidelines to follow and will be given product information sheets.

Rationale:

Before the Purchasing department can act on requests for parts, it must be supplied with specifications for items to be ordered from outside vendors.

Outcomes:

Students will be able to establish material specifications for a given manufacturing situation, and encouraged to utilize vendor expertise when doing so.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill.

Instructional Strategies:

Instructor will briefly cover the concept of material specification sheets and why they must be provided to Purchasing. Then the students will be divided into teams and provided with requirements for a production run. Each team will then be supervised in writing good specifications for Purchasing.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

☒ Reading
☒ Writing
☒ Speaking
☒ Listening

Computation:

☐ Fractions
☐ Decimals
☐ Percents

Personal

Teamwork (Interpersonal):

☒ Assertiveness
☒ Negotiation
☒ Listening
☒ Risk Taking

Change:

☒ Personal Adaption
☐ Professional Adaption

Computer:

☐ Operating Systems
☐ Keyboards
☐ Applications________________________________

Decision Making:

☒ Ethical Reasoning
☒ Logical Reasoning
☒ Flexibility

Problem Analysis:

☒ Identification
☒ Solutions
☒ Evaluation
☒ Implementation

Many types of materials, components, and subassemblies are purchased by companies and contribute to the ultimate reliability and safety of the end product. The area of incoming-material control deals with techniques for achieving the objective of control and establishing a purchaser/vendor partnership.

Incoming-material control involves the receiving and stocking, at the most economical levels of quality, of only those parts whose quality conforms to the specification requirements. A major emphasis is also placed on vendor responsibility. There are two phases of incoming-material quality control. There must be control of materials and parts received from outside sources and control of parts processed by other plants or divisions of the same company (inside sources).

There are eight basic steps within the total quality control program which are common to incoming-material quality control. First is material request and material specification. Once requirements have been defined, materials and parts are requested, usually by materials management in conjunction with production schedules. Specifications, drawings, and all necessary materials data are developed. All necessary quality information (quality requirements, quality levels, reliability requirements, relevant quality plans, certification procedures, and so on) are developed. Material that is critical to safety is identified and specified.

Purchase analysis is initiated to determine the most suitable vendor. Purchase inquiries are sent to, or invited from several vendors. The procurement package provided to potential vendors will include a complete package of the relevant quality information. With large procurements, and where appropriate, precontract award meetings are scheduled with suppliers to specify all purchase requirements, with particular emphasis on quality requirements.

Vendor bids and offers are received from the interested suppliers and reviewed by purchasing with involvement by all functions participating in the plant incoming-material control routine. Existing vendor rating and vendor performance rating data are reviewed. Vendor sample materials and parts are evaluated, and reliability is confirmed. Surveys of vendor quality capabilities are a must and are made at vendor plant sites where appropriate.

Vendors are selected and contracts established or orders placed. Vendor quality assurance requirements are made an integral part of the contracts and orders. Contacts are maintained with vendors while they are in the process of producing or securing the material. Quality assistance is provided to the vendor when appropriate and preproduction samples are approved if required.

Production material is received by the purchaser plant. It is properly tagged, identified for tracing purposes, and routed to the appropriate plant or storage area.

Material is examined for conformance to specifications in accordance with the incoming-material quality plan. Material is then sent to the production line if it is satisfactory or for corrective action if it is unsatisfactory.

Appropriate records are kept, including vendor performance rating documentation and material traceability. Information about the material being received is routed back to the proper plant technical and purchasing personnel. The records kept are used regularly to review inspection and purchasing practices on the material and to maintain vendor rating and vendor performance rating data.

Vendor relations are maintained during the course of shipments by the supplier, including heavy emphasis on close quality communications and taking corrective actions as needed. Ongoing vendor monitoring and audit activities are maintained.

Before Purchasing can act on a request by the plant production control department for placement of orders for a certain material, it must have adequate specifications for the material. Some of these specifications are made available to Purchasing directly from the company and Design Engineering. Other specifications are developed as part of the incoming-material control routine.

Complete **QUALITY WORKSHEET 5** to apply the information learned in this activity.

QUALITY WORKSHEET 5

The information sheet has provided guidelines and information with regard to incoming-material control. The students will be divided into small groups and each group will be given a component, sub-assembly, or raw material to write specifications for. They must be written to be submitted to Purchasing. Specifics are left to the discretion of the instructor depending upon availability of resources.

Alternative Strategies for Activity Number: Quality.005

Each student could be given the same part to write specifications for and then hold a group discussion to write one specification sheet for the Purchasing department.

Learning/Performance Checks for Activity Number: Quality.005

Students will be evaluated based on team effort and cooperation and the content of the specification sheet.

ACTIVITY NUMBER QUALITY.006

PRODUCTION QUALITY CONTROL

Description:

This activity will overview quality control in the production aspect, specifically with regard to testing and inspecting. The student will read the information sheet and use it to answer the questions on the work sheet provided.

Rationale:

The acid test of the worth of a quality control program occurs during the actual manufacture of the product. An understanding of production process control is essential to appreciate the overall quality control concept.

Outcomes:

The student will be able to define the scope of product quality in terms of modern manufacturing, and identify the sequence of events associated with modern quality control.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill.

Instructional Strategies:

The instructor will briefly overview the concept of Product Quality Control and then have the students read the information sheet. Students will then complete the work sheet provided.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
_______ Speaking
___x___ Listening

Computation:

_______ Fractions
_______ Decimals
_______ Percents

Personal

Teamwork (Interpersonal):

_______ Assertiveness
_______ Negotiation
_______ Listening
_______ Risk Taking

Change:

_______ Personal Adaption
_______ Professional Adaption

Computer:

_______ Operating Systems
_______ Keyboards
_______ Applications________________________________

Decision Making:

_______ Ethical Reasoning
___x___ Logical Reasoning
_______ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
_______ Implementation

The high percentage of internal failure costs to direct labor cost illustrates the effect of inadequate control of product quality during the manufacturing process. These ratios can run as high as 20 to 40% for some plants. An integral part of the solution of this problem is a broad-based and efficiently operating series of product-control routines.

Product control involves the control of products at the source of production and through customer service so that any departures from the quality specification can be corrected before defective or non-conforming products are manufactured. Proper service must be maintained in the field to assure full provision of the intended quality to the customer.

Key individuals in the quality-control practices for product control are the men and women who actually produce the product: the machinists, electronic assemblers, testers, production supervisors and foremen. All practices must be built around these employees and managers because it is through them that the bulk of product-control activities must be carried out. Also very heavily involved are mechanical inspection and electrical/electronic test activities.

Process-Control Engineering has a major contribution to product quality. This aspect is responsible in the production phase to ensure that personnel, methods, materials, and equipment are being employed properly and quality procedures are being followed by those performing quality measurements. A primary goal is to determine an ongoing cause-and-effect relationship between the product and the preceding process. These controls can be divided into two basic areas: control of machining or processing of components, and control of assemblies and packaging and on batches. An important aspect of this control is the use of non-destructive evaluations (NDE) to ensure that a product can be tested throughout the manufacturing process and that test will not have any negative effects on (i.e., destroy) the product.

The pattern for product control involves seven areas. First is the receipt of order for the part, material, or assembly in the manufacturing area. Then the requirements of the order are examined and steps are taken to make the order ready for production. This includes product and process classification and correct assignment of all necessary equipment and controls. Next the order is released for production, followed by strict control of material while in the manufacturing process. After manufacturing, the product is approved, a quality audit is conducted with specific reference to safety and reliability and the results are evaluated. Last comes packaging and shipment. If a component, it may only be transported to the area where it will be used in assembly.

Standards must be built into product-control activities, and should include four areas:

1. Product requirements such as its specifications, its guarantees, and tolerances.
2. How it is to be made. The quality factors in planning for manufacture, determination of processing equipments upon which the article may be produced, and selection of required tools, jigs, fixtures, software, and guides for numerical control.
3. What is important on the article: classification of characteristics, inspection and test requirements, point of inspection or test, and quality levels for sampling?
4. Lastly, how is the quality to be assured: Quality information equipment to be used, reliability testing to be performed, automatic inspection and testing practices, and computer-aided quality practices that are integrated with computer-aided design and manufacture.

When standards have been determined, actual production-control activities are then developed. Listed below are some of the typical factors that must be evaluated during this process:

1. What type of manufacturing process will be used?
2. What are the manufacturing quantities?
3. What type of shop personnel will be required?
4. What type of product is actually being manufactured?
5. What product-control procedures are needed on other processes in the shop?
6. How are product-control procedures accepted by the personnel?

To apply the information learned in this activity, complete **QUALITY WORKSHEET 6**.

QUALITY WORKSHEET 6

Using the information sheet provided, list the production functions below in their correct order:

Shipping Quality Control
Complaint Analyses
Nondestructive Evaluation
Nonconforming Parts Disposal
Proper Material Flow
Packaging Quality Control
Mechanical Inspections
Acceptance Sampling
Process Design Review
Process Capability Study

1.____________________________

2.____________________________

3.____________________________

4.____________________________

5.____________________________

6.____________________________

7.____________________________

8.____________________________

9.____________________________

10.___________________________

Alternative Strategies for Activity Number: Quality.006

Give the students a product/part to be manufactured and then have them answer the last six question in the information sheet while working in small groups. When they are divided into groups, assign one question per group and then have a discussion with the entire class to summarize answers to all questions.

Learning/Performance Checks for Activity Number: Quality.006

Evaluate each student's work sheet based upon the answer sheet provided below.

1. acceptance sampling
2. process design review
3. mechanical inspection
4. nonconforming parts
5. shipping
6. process capability study
7. proper material flow
8. nondestructive eval
9. packaging
10. complaint analysis

ACTIVITY NUMBER QUALITY.007

PRODUCT/PROCESS INSPECTION

Description:

A group activity designed to establish a plan for the acceptance sampling of a product and then to actually conduct an inspection.

Rationale:

The actual performance of the inspection is the heart of a quality program. Without performing a real inspection, quality control can have no meaning.

Outcomes:

The student will be able to establish a plan for the Acceptance Sampling of a given product and conduct the inspection on given parts.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 465-518)

Instructional Strategies:

Instructor will use the guidelines provided and have the class develop an inspection sheet for an assigned part. After inspection procedures have been completed, the class will be divided into small groups (no more than 3 per group), and each group will conduct inspections on a number of parts. Whatever part is selected, a large quantity will be required, and it must have defects.

Safe Practices:

Standard practices for shop environment.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Student Information Sheet Number: Quality.007

Lot-by-lot Acceptance Sampling by attributes is the most common type of sampling. With this type of sampling, a predetermined number of units (sample) from each lot is inspected by attributes. If the amount defective is less than the prescribed minimum, the lot is accepted; if not, the lot is rejected as being below standard. Each lot in the shipment or order is sampled and either rejected or accepted. Acceptance Sampling can be used either for the amount defective or for defects per unit.

Acceptance Sampling can be performed in a number of different situations when there is a consumer-producer relationship. The consumer and producer can be from two different companies, two different plants within the same company, or two departments within the same plant. In any case, there is always the problem associated with the acceptance of goods.

Acceptance Sampling of the product is most likely to be used in one of five situations.

1. When the test is destructive.
2. When the cost of 100% inspection is high in relation to the cost of passing a defective item.
3. When there are many similar items to be inspected.
4. When information concerning producer's quality or X bar charts are not available.
5. When automated inspection is not used.

Acceptance Sampling has the following advantages when compared with 100% inspection:

a. More economical.

b. Less handling damage.

c. Requires fewer inspectors.

d. Makes lot-by-lot versus piece-by-piece decisions.

e. Rejection of entire lots rather than the return of defective ones.

Some of the disadvantages of Acceptance Sampling are:

- a. There are certain risks of accepting defective lots and rejecting good lots.
- b. More time and effort are devoted to planning and documentation.
- c. Less information is usually provided about the product.

Once it has been decided to conduct a sampling inspection, it must be determined how large a lot size is and how many will actually be inspected from each lot. After this has been done, a procedure for inspection must be agreed upon by the quality control department and an inspection sheet designed for the inspector to complete.

Listed below are some suggested items for including on the sheet:

1. Drawing number, group or part number, and revision letter or number for identification.
2. Name of part as designated on the drawing.
3. Area where inspection is to be performed and type of inspection.
4. Part supplier, either internal department or outside vendor.
5. Acceptable Quality Level (AQL) in use.
6. Name of person designing inspection procedure sheet.
7. Date inspection sheet is originated.
8. Signature of inspector.
9. Signature of foreman or general foreman approving the inspection procedure.
10. AQL for each characteristic or 100%.
11. Characteristics being checked in order of checking.
12. Setup checks should be listed as well as the check number of the setup inspector.
13. List of inspection equipment or method used.
14. Lot size.
15. Actual sample size inspected.

16. Symbol for OK characteristics and what indication for nonconforming parts.

17. Total number of nonconformances for each AQL.

18. Use sampling tables supplied by Quality Control.

    a. Select enough pieces for largest sample size required.

    b. Samples to be selected at random from all sections of container or lot.

    c. If several containers make up a lot, divide the sample size by the number of containers and take the same number from each container at random.

To apply the principles learned in this information sheet, complete **QUALITY WORKSHEET 7.**

QUALITY WORKSHEET 7

Using the guidelines provided in the Information Sheet, design a test sheet for a part supplied by your instructor. After class discussion, a standard sheet and procedure will be designed. You will then be divided into small groups and provided with sample parts for actual inspection.

Alternative Strategies for Activity Number: Quality.007

Provide the students with a preprinted inspection sheet and a number of parts to be inspected. Have each student conduct an actual inspection and turn in the inspection sheets with a decision whether or not to accept or reject the lot based upon this inspection. Compare the results and use them for a class discussion with regard to acceptable quality levels.

Learning/Performance Checks for Activity Number: Quality.007

Students should be evaluated upon quality of work and participation in class exercise of creating inspection procedures. They should also be evaluated as a group on whether or not they found all the defects in the parts they were provided or if they found defects that were not there.

ACTIVITY NUMBER QUALITY.008

NON-CONFORMING PARTS DISPOSAL

Description:

Students will be divided into small groups to determine procedures for disposing of nonconforming parts.

Rationale:

Not all parts coming in will be suitable for production operations. These must be disposed of in a quick and orderly manner so as not to disrupt the production schedule.

Outcomes:

Student will be able to establish a procedure for disposing of nonconforming parts.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 289, 290, 706-711, 714-715)

Instructional Strategies:

Have the students read the information sheet explaining nonconforming parts disposal. Then divide students into small groups and have them use the guidelines provided to establish a procedure for disposal of the parts that did not conform to standards in the previous inspection exercise. Arrange the groups so that the procedures can be discussed by the whole class and a composite procedure decided on.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Student Information Sheet Number: Quality.008

Suggested options for disposal of nonconforming materials:

1. The discrepancy is reported on a form with all pertinent inspection and test data.
2. The discrepancy is analyzed for the effect the defect will have on outgoing product quality.
3. Disposition is recommended.
4. Where design is affected, the design engineer who developed the product specification should approve the disposition.
5. The signed report becomes the authority for disposition, and copies of this report are distributed.
6. Copies are directed to production for corrective action.
7. Convene committee consisting of representatives from Process Control Engineering, Design Engineering, and Purchasing.

   Some possible alternatives for this group to decide on are:

   a. Reject the entire lot, and return it to the vendor.

   b. 100% sort the lot, and return the nonconforming units to the vendor. The vendor bears the cost of the sorting inspection.

   c. 100% sort the lot at vendor's expense, and repair the nonconforming parts--also at the vendor's expense.

   d. Accept the entire lot, based upon a special disposition which temporarily relaxes specification requirements.

   e. Alternatives b or c, except that the purchaser bears part or all of the extra inspection and repair costs.

For application of these guidelines, complete **QUALITY WORKSHEET 8**.

QUALITY WORKSHEET 8

Using the guidelines provided in the information sheet, students will be divided into small groups to design forms and procedures to be used to dispose of the parts that were found to be nonconforming in the inspection conducted in the previous activity. After reaching agreement in groups, the instructor will present group options to the class and the class will decide on the best composite procedure to be used for parts disposal.

Alternative Strategies for Activity Number: Quality.008

Have students determine a disposal procedure for the parts they rejected in the previous activity using the guidelines provided in this activity.

Learning/Performance Checks for Activity Number: Quality.008

Students should be evaluated on the group participation and the reasoning behind their support of particular disposal alternatives.

ACTIVITY NUMBER QUALITY.009

PACKAGING AND SHIPMENT QUALITY CONTROL

Description:

Students will compete in groups for the best packaging of a particular product. Instructor will choose a final product and require each group to package it for shipment in the best possible way. A uniform test will then be conducted on each package to test for effectiveness.

Rationale:

A manufacturer can make the best product in the world, but if it isn't packaged properly and arrives at the consumer unable to perform its function, it is no longer the best.

Outcomes:

As a member of a Product Control Team, the student will assist in developing and testing a package for shipment.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 159-590, 594)

Instructional Strategies:

Instructor must choose a product for packaging and provide packaging materials. The students must decide on a test method to determine if a package will arrive at the customer's site able to perform. Then the students will be divided into groups and asked to find a packaging technique or method they feel will do the best job. Based upon predetermined test results, the best packaging technique or method will be selected.

Safe Practices:

Standard shop safety practices.

Integrative Skills

Communication:

___x___ Reading
___x___ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

___x___ Assertiveness
___x___ Negotiation
___x___ Listening
___x___ Risk Taking

Change:

___x___ Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications______________________________

Decision Making:

___x___ Ethical Reasoning
___x___ Logical Reasoning
___x___ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
___x___ Implementation

Student Information Sheet Number: Quality.009

The only product reliability that counts is what the customer can actually experience. There is not much point in having a device with the best design in the world, that has been manufactured with the finest quality possible, if it arrives at the customer site unable to perform up to standards because of damage during shipment.

The design of packaging is often a low priority item, even though it is essential to the proper performance of the product. Even if the size of a company cannot afford a special packaging department, the function should be the responsibility of some part of the organization.

After packages have been designed, they should be evaluated. If simulated shipping tests are conducted by impact testers, vibration tables, compression testers, and the like, the parameters of stresses that the packaged product will experience during shipping must be known.

If actual trial shipments are made, care must be used to see that they are representative of what may be encountered on all shipments. A single shipment can not be expected to render definitive results. Routes, method of transportation, and extremes of temperature and humidity should be factors considered in any testing conducted on packaging.

Even though proper and effective packaging is often overlooked, it must be a high priority in a Quality Control program. You can not have the best design talent, the highest quality manufacturing methods, and stay in business if the product arrives at the customer in a condition that affects its peak performance.

To apply this information sheet, complete **QUALITY WORKSHEET 9.**

QUALITY WORKSHEET 9

Students will be assigned a product that must be packaged for shipping. It is best to decide first, what means of shipping will be used: bus, truck, rail, air, etc. Then the students as a class should decide on a method(s) for testing the package to determine if it will withstand the rigors of shipping. After testing methods are determined, the students will be divided into package design groups. They will package the product and then submit it for testing. They will then judge which packaging method performed best.

Alternative Strategies for Activity Number: Quality.009

Students can be divided into groups to design a package for a given product. Each group will then submit its design to independent experts recruited from faculty, advisory committee members, or industry professionals. After the best design is chosen, all will be critiqued as to their advantages and disadvantages.

Learning/Performance Checks for Activity Number: Quality.009

Students will be evaluated upon their participation in class and group activities. Grades can be assigned based upon how well the packaging met the testing criteria.

ACTIVITY NUMBER QUALITY.010

CUSTOMER SATISFACTION AND SERVICE

Description:

This is a group activity which will produce a set of guidelines or procedures for all employees of a company to provide quality customer service and provide maximum customer satisfaction for a given product.

Rationale:

Customer satisfaction is the true measure of quality for any given product. Without it, you may be out of business. When all employees of a company are dedicated to customer satisfaction and quality, success will be easier to attain.

Outcomes:

Students will be able to develop guidelines and establish procedures for increasing customer satisfaction for all employees to follow.

Tools, Materials, Machines, and Resources:

1. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (p. 103)
2. Gitlow, H., & Gitlow, S. (1987). The Deming guide to quality and competitive position. Englewood Cliffs, NJ: Prentice-Hall. (pp. 13-26)
3. Schonberger, R. (1986). World class manufacturing. New York: Free Press. (pp. 169-171, 205)

Instructional Strategies:

Instructor will provide the students with a brief overview on the importance of customer service and satisfaction. Students will then work in groups to identify an area of dissatisfaction, conduct a survey to confirm this, and then recommend a set of guidelines or procedures by which all employees can remedy this lack of service situation.

Safe Practices:

Not applicable.

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Integrative Skills

Communication:

___x___ Reading
___x___ Writing
___x___ Speaking
___x___ Listening

Computation:

______ Fractions
______ Decimals
______ Percents

Personal

Teamwork (Interpersonal):

___x___ Assertiveness
___x___ Negotiation
___x___ Listening
___x___ Risk Taking

Change:

___x___ Personal Adaption
______ Professional Adaption

Computer:

______ Operating Systems
______ Keyboards
______ Applications______________________________

Decision Making:

___x___ Ethical Reasoning
___x___ Logical Reasoning
___x___ Flexibility

Problem Analysis:

___x___ Identification
___x___ Solutions
___x___ Evaluation
___x___ Implementation

Student Information Sheet Number: Quality.010

One of the most important things to do when setting up a quality control program is to identify all customer requirements for a given product. When "quality control" is talked about, quality should not mean simply the best possible product, but should mean the best product for satisfying customer needs with regard to that product.

The most important considerations are what the actual customer use of the product will be and what the selling price of the product will be, but there are other factors to consider as well. Among these are:

The specifications and operating characteristics

The life and reliability objectives

The safety requirements

The applicable standards

The engineering, manufacturing and quality costs

The production conditions under which the product is manufactured

The field installation, maintenance, and service objectives

The energy utilization and material conservation factors

The environmental and other side effects

The costs of customer operation, use, and product service

The purpose when considering all these variables is to establish the right balance between the cost of the product and service, and the value the product brings to the customer.

By examining small samples of finished products only from the point of view of the customer, useful predictors of customer satisfaction can be determined. Results of this type of customer-centered quality audit, together with other measurements after the product is in use, will evaluate the effectiveness of the quality control program from the customer's viewpoint. This kind of measuring takes into account data on field failures, service call rates, analysis, and reporting of customer attitude trends about the product quality, service, and reliability.

Customer attitude is determined by obtaining and measuring the opinions, impressions, reactions, and degree of satisfaction of each customer with regard to the overall efforts of the company toward providing quality for its products and/or services. Among the important attitudes which can be measured are the following:

Quality of shipment

Quality of product installation

Quality of product operation

Quality of product functional design

Maintainability (how easily it was repaired if it failed)

Serviceability (how easy the instructions were to follow)

Quality of service

There are many methods used to collect information on customer attitudes. The most generally used is the questionnaire sent directly to the customer. Other approaches include telephone interviewing or personal visits by a company representative. Useful information can also be gathered by examining buying trends, by comparing competitor products, by making model-to-model comparisons, and examining geographic area differences.

While the satisfaction of all customers is important, from the practical standpoint, it must be realized that some accounts take precedence over others when it comes to volume, size, revenue, profit, potential new business, and image. Because of this, many companies develop a customer rating plan. This plan is a means of weighing the customer response between "critical" customers and "major" customers.

Another important factor is the analysis of causes of customer dissatisfaction with the product. This analysis must be structured so that necessary areas of corrective action can be pinpointed to the production operation and the required improvements for quality can be initiated. The most likely sources for this information are service shop tickets, service call reports, service engineers' reports, installation reports, returned product reports, and data on complaints. From this information, service call rates and complaint service can be reduced and outgoing product quality can be improved.

Customer satisfaction must become the focus of all thinking in a corporation. Providing customers with goods and services that meet their expectations and needs at a price they are willing to pay is the most important criterion in a manufacturing operation today. This can only be achieved by constantly improving quality in never-ending cycles. Companies can no longer try to increase profits by producing large quantities of low quality products. Customers know what they want and what they expect to pay for a particular item or service. Marketing quality products at a fair price is the only way to satisfy customers. If you satisfy customers, profits will increase in the long run. But satisfying customers is the primary goal.

To apply the information here, complete **QUALITY WORKSHEET 10**.

QUALITY WORKSHEET 10

Since students are customers too, they can probably agree on a number of things in the educational area which they feel are not being serviced properly. The instructor will lead a class discussion to identify areas where students feel need more attention with regard to customer (student) services. When several areas have been identified, the students will break into groups with at least one group assigned to each identified area. Each group is then responsible for conducting a survey to firmly establish their belief of dissatisfaction, and then to recommend a set of guidelines or procedures by which this lack of service can be rectified.

Alternative Strategies for Activity Number: Quality.010

Using the information sheet as a guide, students will be divided into three groups whose purpose is to establish company policy for each employee to follow to aid in customer satisfaction.

One group will be assigned to work on Beliefs. This group should define how employees will always behave toward the customer, whether it is outside the company or the person in the next work center.

Another group will work on Goals.This group will define what each employee must strive to accomplish each day to guarantee total customer satisfaction.

The third group will work on Initiatives. This group will define how the goals and beliefs will be accomplished. This must be done in terms of company-wide methods and things each employee must do.

This activity will require a liaison person from each group to work with the other groups, because the outcomes here are dependent on each other. One group cannot finish without the assistance of the other groups. This will be an experience in teamwork.

Once each group has reached its individual goals, the class will meet as a whole and adopt the guidelines as established by each group. The guidelines should then be published so each person will have a copy for future reference.

Learning/Performance Checks for Activity Number: Quality.010

Students should be evaluated based upon their participation in group and class activities and on the results of the final product the class produces.

ACTIVITY NUMBER QUALITY.011

PRODUCT LIABILITY

Description:

This is a group activity in which all class members will participate in a mock trial. All parties will have to prepare their case. A judge and jury will be selected, and a verdict will be rendered.

Rationale:

By experiencing the possible outcomes in a lawsuit about product liability, even through simulation, students will have a better understanding of the cost and impact of poor quality products.

Objective:

Students will be able to, as part of a simulation team, enact the legal aspects of product liability law to include the plaintiff, the defendant, expert witnesses, the outcome, and possible financial loss.

Tools, Materials, Machines, and Resources:

1. Babb, H. W., & Martin, C. (1976). Business law (2nd ed.).
2. Besterfield, D. H. (1986). Quality control (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall. (pp. 313-327)
3. Corley, R. N., & Robert, W. J. (1975). Principles of business law (10th ed.). Englewood Cliffs, NJ: Prentice-Hall.
4. Ross, M. J. (1975). Handbook of everyday law (3rd ed.). New York: Fawcett Crest. (pp. 359-369)

Instructional Strategies:

Instructor will divide the class to play the following parts in a mock trial: the jury, the plaintiff, the defendant, and expert witnesses. The basis for the lawsuit will be an injury caused by a product manufactured by the defendant. It is important that this trial be taken as seriously as possible. While there is not enough time to make everyone expert in business and product liability law, each group should have sufficient time to do some research on its roles in addition to the information sheet. It would be ideal to involve the entire department, school, or even the community in this activity. Time constraints, being what they are, the involvement level is left to instructor discretion.

Safe Practices:

As required for courtroom trial.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

The old attitude of "caveat emptor" ("let the buyer beware") is being replaced by a growing concern on the part of federal, state, and local governments for the protection of the consumer. The consumer is defined as a person who buys, leases, or obtains goods, services, or credit for personal, household, or family purposes. The protection offered includes steps taken to assure consumer personal safety in the use of products purchased and to prevent any unconscionable and deceptive practices by suppliers of these products. The practical result of this concern is the enactment by the federal government of the Consumer Product Safety Act, the Uniform Consumer Sales Practices Act, and the Uniform Commercial Code.

The federal Consumer Product Safety Act was passed by Congress to protect the consumer from unreasonable risk of injury resulting not only from the ordinary use of a product but from causes not anticipated by the user. This involves products produced or distributed for sale for personal use of consumers, as to their performance, composition, contents, design, construction, finish, or packaging.

The Uniform Consumer Sales Practices Act is promulgated and recommended to the states by the National Conference of Commissioners on Uniform State Laws. When adopted by a state it becomes the law of that state. The purpose of this act is to protect consumers from deceptive and unconscionable sales practices and to establish a standard of consumer sales practices consistent with the policies of the Federal Trade Commission.

Most of our laws, relating to business and commercial transactions, originated with the "law merchant." This was a body of regulations established through the centuries by merchants, mariners, and businessmen of the trading world to carry on commerce with confidence and security. These rules were later incorporated with the other branches of law into the English Common Law, and now adopted by most of the states as the Uniform Commercial Code.

The primary concern here will be with product liability and the Consumer Product Safety Act. The purposes of this act are:

1. To protect the public against unreasonable risks of injury associated with consumer products.

2. To assist consumers in evaluating the comparative safety of consumer products.

3. To develop uniform safety standards for consumer products and to minimize conflicting state and local regulations.

4. To promote research and investigation into the causes and prevention of product-related deaths, illnesses, and injuries.

Two types of law are involved in product liability lawsuits, contracts and torts. A contract is an agreement between two or more parties which is enforceable in a court of law. Since warranties are part of contract law, lawsuits for a breach of warranty are based on contract law. A tort is a civil wrong committed by the invasion of any personal or private right which each person enjoys by virtue of federal and state laws. The majority of states have adopted the doctrine of strict liability in tort. This means that the injured person needs only to prove that a product was unreasonably dangerous to win his/her case.

A lawsuit is a civil suit seeking money damages for injuries to either a person or his/her property, or both. It is instigated by the injured party, called the plaintiff, and filed in a court of law as a claim against the responsible parties. The plaintiff must prove that (1) the product was defective and unreasonably dangerous, (2) the defect was present when the product changed ownership, and (3) the defect caused the injury.

While anyone along the trail of commerce (manufacturer, wholesaler, or retailer) can become a defendant in a lawsuit, it is usually the manufacturer who is held liable to the injured party. The manufacturer is the one with the "deepest pocket" or the one from whom the largest award can be obtained. In general, the defendant tries to prove that the product was not defective and not unreasonably dangerous.

Expert witnesses are engaged by both sides of the litigation to prove their arguments. The defendant uses the services of expert technical witnesses within the manufacturing organization as well as outside or independent technical experts. Expert witnesses must have technical competency relative to the area of testimony, their character must be above reproach, and most important, they must have the ability to communicate with the judge and jury.

The judge is the person who oversees the trial and makes sure that proper legal procedures are followed by both the plaintiff and the defendant. The judge must also instruct the jury as to their responsibilities. The jury is made up of ordinary men and women and they must decide in favor of either the plaintiff or the defendant.

As a result of a lawsuit or to prevent future ones, there are a number of possible areas of financial loss. These areas include trial expenses, court judgments, bankruptcy, insurance premiums, and product recall. Other financial considerations that may result directly or indirectly from a product liability lawsuit are the cost or recall, replacement, or repair of a product; cost of damage to a company's reputation and customer dissatisfaction; cost of a hold or delay in production due to a potential defect; and cost of increased quality costs for prevention or appraisal.

To apply this information, complete **QUALITY WORKSHEET 11.**

QUALITY WORKSHEET 11

Students will be divided into groups for role playing in a mock trial. Groups will consist of plaintiff, defendant,expert witnesses for both sides, and a jury. Each group will have to research its roles and prepare for the trial. The plaintiff will be given a product by the instructor which will form the basis of the lawsuit. When each group has prepared sufficiently for the trial, a judge will be appointed by the instructor and the trial will begin. After the jury decision has been reached, a class discussion will be held to critique the outcome.

Alternative Strategies for Activity Number: Quality.011

In small groups, the students could research various product liability lawsuits and prepare critiques of them to be presented to the entire class for discussion purposes.

Learning/Performance Checks for Activity Number: Quality.011

No individual evaluations will be made in this activity. It will be the instructor's responsibility to maintain control and continuity in this exercise. It is recommended that the instructor find a volunteer from outside the classroom to be the judge and to assist in the trial.

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ACTIVITY NUMBER QUALITY.012

CLAIMS, COMPLAINTS, AND PRODUCT RECALL

Description:

This is a group activity dealing with complaints, claims, and product-recall plans. Using references and information sheets, students will devise plans for handling a specific product.

Rationale:

Service and procedures after the sale are an integral part of the manufacturing process. Understanding the complete cycle of business is an aid to a successful manufacturing career.

Outcomes:

Students will be able to, as part of a Product Liability Team, establish procedures for handling claims and complaints and create a Product-Recall Plan for given products.

Tools, Materials, Machines, and Resources:

1. Besterfield, D. H. (1986). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 37, 38)
2. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 313-327)

Instructional Strategies:

Using information sheets and references, instructor will overview complaints, claims, and the product-recall process. Students will then be split into three groups, one for each area. Each group will develop a set of procedures for handling its assigned task for an instructor-assigned product. An actual product may be assigned or one that has gained either local or national notoriety for defects. Upon completion, all three procedures should be printed for distribution to the entire class.

Safe Practices:

As appropriate for the assigned product.

Integrative Skills

Communication:

__x___ Reading
__x___ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications_____________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

A complaint or a claim is a communication between the marketplace and the manufacturing operation concerning the performance of a particular product. This information serves to alert the manufacturer to the need for corrective action. Analysis of complaints can lead to a change in product design or manufacturing that will reduce the exposure to disabling injuries.

The investigation of bodily injury or property damage claims or product safety complaints should be acted upon quickly. Usually, the notice of a claim or complaint is given to a dealer, distributor, or employee. This initial notice is sent to the proper department for action. An investigator reviews the situation and determines the following:

1. The cause of the claim or complaint.
2. The nature and seriousness of the injury if one occurred.
3. The defect that caused the situation, if there was a defect.
4. The age of the defect and if it was present when the product was sold.
5. The negligence of the parties.

An early investigation can lead to quick settlement of reasonable claims or the preparation of defenses for those claims which may require legal work. The defense of a product liability lawsuit makes it necessary to have available the design, production, and sales records for a product. The types of records that should be retained and readily available are:

1. Product development and test records.
2. Results of process, product, and system inspection and audits.
3. Records of verbal and written communications with customers relative to requirements, product application, nonstandard materials, and claims.
4. Original design data.
5. Service-life data.
6. Acceptance and approvals by government agencies, customers, or independent testing companies.
7. Critical raw material acceptance records.

While the cost of recalling a product varies with the type of product and the quantities involved, the costs are substantial and have forced companies into bankruptcy. An effective recall contingency plan helps to minimize the recall costs and the product liability risk. Once notification of a defective product is received, the company must decide whether or not to recall all products suspected of having the defective condition. Consideration will be given to:

1. Determination of the maximum exposure to personal injury or property damage if the product is not recalled.
2. The form of communication (radio, TV, newspaper, telephone, or registered letter) to use in contacting the users of the product.
3. Determining if the product will be repaired, or replaced, or if the customer will be reimbursed.

While each situation is different, it always pays to have a backup plan. Even though all efforts are put into delivering a quality product to the consumer, a defect can occur. It is best to have some general guidelines in place to handle claims, complaints, and recalls.

To apply this information, complete **QUALITY WORKSHEET 12**.

QUALITY WORKSHEET 12

There will be three worksheets in all, one for each group.

As part of the ____________________________ team, you will be required to document procedures you establish for handling a __________________________. You will also be asked to explain why each step of the procedure has been instituted.

__________________title__________________

1. ____
____
____

because ____
____
____

2. ____
____
____

because ____
____
____

3. ____
____
____

because ____
____
____

4. ____
____
____

because ____
____
____

5. ____
____
____

because ____
____
____

Alternative Strategies for Activity Number: Quality.012

Instead of having the groups develop claim, complaint, and recall procedures for a given product, have the groups research what local companies have done to handle these situations. A time should be set aside for a representative from each group to report on their industry findings.

Learning/Performance Checks for Activity Number: Quality.012

Students should be evaluated upon participation in work groups and class participation. Also include the result of their procedures as far as practical implementation goes.

ACTIVITY NUMBER QUALITY.013

QUALITY COST IMPROVEMENT PROJECTS

Description:

This is a group activity requiring students to work in small groups to develop a Quality Cost Improvement Project for a given product.

Rationale:

A person employed in manufacturing needs to know how important quality is, what its total costs are, and different methods available to reduce cost and improve quality.

Outcomes:

Students will be able to, when provided data for a given product, develop a Quality Cost Improvement Project to reduce costs and improve quality for a given product.

Tools, Materials, Machines, and Resources:

1. Besterfield, D. H. (1986). Quality control (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall. (p. 312)
2. Feigenbaum, A. (1983). Total quality control (3rd ed.). New York: McGraw-Hill. (pp. 109-145)

Instructional Strategies:

The instructor will supply each student with quality cost data for a given product and a list of projects for improving quality cost. The class will then be divided into small groups. Each group will decide which project to undertake and why they feel it will give the best results. Each group will then outline a plan for the project and decide on a representative to present it to the entire class. When the plans are presented to the class, students should explain why that project was chosen and what benefits it will provide. The class will then decide which project will be put into effect for the product based upon the presentations given.

Safe Practices:

Not applicable.

Integrative Skills

Communication:

__x__ Reading
__x__ Writing
__x__ Speaking
__x__ Listening

Computation:

_____ Fractions
_____ Decimals
_____ Percents

Personal

Teamwork (Interpersonal):

__x__ Assertiveness
__x__ Negotiation
__x__ Listening
__x__ Risk Taking

Change:

__x__ Personal Adaption
_____ Professional Adaption

Computer:

_____ Operating Systems
_____ Keyboards
_____ Applications______________________________

Decision Making:

__x__ Ethical Reasoning
__x__ Logical Reasoning
__x__ Flexibility

Problem Analysis:

__x__ Identification
__x__ Solutions
__x__ Evaluation
__x__ Implementation

Quality costs cross department lines by involving all the activities of the company like purchasing, manufacturing, design, and service. Some costs such as inspection, instrumentation, and salaries are easy to identify, but costs associated with scrap and rework are more difficult to pinpoint. There are also costs involving customer dissatisfaction and loss of reputation which are difficult to identify.

Quality costs are a very important management tool. They provide a method of assessing the overall effectiveness of the quality program and a means of establishing programs to meet overall needs. They provide a method of determining problem areas and action priorities, a technique to determine the amount of effort between the various quality activities, and information for pricing products or bidding jobs.

The cost of quality may be as high as 25% of the sales dollar for a manufactured product, and as high as 40% for a service. Quality costs are an excellent area for cost reduction, which can lead to increased productivity. Generally speaking, as quality improves, overall cost is reduced.

The cost of quality can be divided into two basic areas, direct and indirect costs. Direct quality costs are separated into the categories of prevention, appraisal, internal failure, and external failure. Each of these four categories is made up of its own subcategories.

Prevention costs are associated with personnel engaged in designing, implementing, and maintaining the quality system. Prevention costs are a measure of the investment made prior to producing a product. These costs include: quality engineering, design and development of equipment, quality planning by others, quality training, and other expenses.

Appraisal costs are those that have to do with measuring, evaluating, or auditing products, components, and purchased materials to ensure they conform with quality standards and performance requirements. These costs are incurred to determine the condition of the product and assure that it meets specifications. These costs include: inspection and test of incoming material, inspection and test in setup, prototype, in-process, final, and shipping, product-quality audits, materials and services consumed, and equipment calibration and maintenance.

Internal failure costs occur when products, components, and materials fail to meet quality requirements prior to transfer of ownership to the customer. These are costs that would disappear if there were no defects in the product. These costs include: scrap, rework, failure analysis, reinspection, faulty suppliers, and downgrading or the selling of seconds.

External failure costs occur when the product does not perform satisfactorily after transfer of ownership to the customer. These costs would also disappear if there were no defects in the product. These costs include: complaints, rejected or returned products, repair, warranty charges, errors, and liability.

In addition to the direct operating quality costs, the indirect quality costs and their effect on the total cost of sales must be considered. Indirect quality costs can be divided into three categories: customer-incurred quality costs, customer-dissatisfaction costs, and loss-of-reputation costs.

Customer-incurred quality costs include costs to the customer due to equipment down time, repair costs after the warranty period, and transportation costs. Customer dissatisfaction is usually high when the defect level is high, and low when the defect level is low. Loss of reputation costs reflect the customer's attitude toward the company rather than an individual product.

Most quality cost improvement projects will be based on cost analysis and the creativity of the quality prevention planners. They will be unique to a particular operation, machine, type of defect, product, and so on. Improvement projects that have general application are:

Product design reviews
Process design reviews
Supervisor quality training
Zero-defect programs
Supplier defective material recovery programs
Supplier rating systems
Sampling plan analysis
Inspection system analysis
Automatic inspection
Operator inspection before and after processing

These are just a few of the possible quality cost improvement projects. The creativity of involved individuals will determine what project will be implemented.

To apply this information, complete **QUALITY WORKSHEET 13**.

QUALITY WORKSHEET 13

Assign each student a company and the task of obtaining a Quality Cost Report to share with the class. The purpose would be to illustrate the true cost of doing business in terms of quality. In researching these costs with local companies, the students should be encouraged to seek guest speakers from accounting or quality departments to share information in a class discussion.

Learning/Performance Checks for Activity Number: Quality.013

The students will be evaluated based upon group and class participation. Projects will be evaluated based upon the overall benefit to the quality/cost of the product and their advantages/disadvantages versus each other.

APPENDIX

ILLINOIS STATE LEARNING OUTCOMES ANALYSIS

ILLINOIS STATE LEARNING OUTCOMES

Mfg. Tech. Curriculum Activities	State Goals for Learning: Language Arts 1	2	3	4	5	Mathematics 1	2	3	4	5	6	Bio/Phys Sciences 1	2	3	4	SS 1
Measurement																
1. Purp. & Uses of Ms. Sys.	x	x													x	
2. Uses of Measur. in Mfg.	x	x	x			x	x								x	
3. Dynamic Measurements	x	x				x	x		x						x	
4. Errors in Meas. & C. Pro.	x	x														
5. Costs in Measuring	x	x														
6. Coordinated Measuring	x	x				x	x		x						x	
7. Vision Meas. Systems	x	x				x	x								x	
8. Decid. on Metric Meas.	x	x	x							x	x		x	x	x	x
9. Produc. Meas. Decisions	x	x	x							x	x		x	x	x	x
Print Interpretation																
1. Print Interpretation	x	x														
2. Types of Dwgs. & Purp.	x	x														
3. Notes & Dimensioning	x	x				x			x							
4. Determining Mater. Rqmts.	x	x				x			x	x	x					
5. Produc. Plan. from Prints	x	x				x			x	x	x		x		x	x
Layout & Inspection																
1. Layout for Min. Mat. Waste	x	x				x	x		x		x					
2. Templates for Layout	x	x				x			x							
3. Jigs & Fix. to Lessen Layout	x	x				x			x		x					
4. Deg. of Prec. for LayInsp.	x	x				x	x		x							
5. Const. Lay. & Insp. Gage	x	x				x			x						x	
6. Insp. Plan. & Measuring	x	x				x			x		x					
7. Inspection Ethics	x	x				x										
8. Automated Inspection Proc.	x	x				x									x	
Occupational Safety & Health																
1. Machine Guarding	x	x	x										x	x	x	
2. Stock Control	x	x														
3. Safety in Autom. Environ.	x	x	x										x	x	x	
4. Chem. Haz. in Workplace	x	x										x	x			
5. Chem. Spills in Environ.	x	x											x	x		
6. Fire Safety	x	x											x			
7. Safe Prac. in Workplace	x	x	x							x			x	x	x	
8. Safety Video Production	x	x	x													
9. Accident Report	x	x														
10. Ergonomics & Safety	x	x								x	x	x	x			
11. Ergonomic Design	x	x	x			x			x			x	x	x		
12. Product Liability	x	x											x	x		
13. Product Liab.--Case Stud.	x	x	x													
14. Pers. Protec. Equipment	x	x										x	x			
Business Economics																
1. Bus. Sim.-Profit & Loss	x	x	x			x					x		x			
2. Bus. Sim.-Wag., Hir. & Fir.	x	x	x													x
3. Bus. Sim.-Underst. Overhd.	x	x	x			x										
4. Bus. Sim.-Tech. & Your Job	x	x	x										x			x
5. Cost of a Product	x	x				x										
6. Value of a Part	x	x														
7. Hmn. Res. Edu., Exp. & Trn.	x	x											x	x		
8. Consumer Satisfaction																

ILLINOIS STATE LEARNING OUTCOMES
(continued)

Mfg. Tech. Curriculum Activities	State Goals for Learning: Language Arts					Bio/Phys Mathematics						Bio/Phys Sciences				SS
	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	1
Product & Process Control																
1. Product Design	x	x	x			x			x	x	x	x	x	x	x	x
2. Process Design	x	x	x							x	x		x	x	x	x
3. Inventory Control	x	x													x	
4. B/M & Requisitions	x	x				x										
5. Trans. of Inven. Material	x	x													x	
6. Plant Layout Design	x	x	x			x				x	x		x	x	x	x
7. Flow Diagram for Produc.	x	x														
8. Material Handling Systems	x	x													x	
9. Mat. Trans. Thr. Produc.	x	x														
10. Work-In-Process Control	x	x								x						
11. Quality Stand. for W-I-P	x	x								x					x	
12. Computer. Contr. Applica.	x	x				x			x							
13. Automated Mfg. Systems	x	x													x	
14. Prod. Iden., Pkg., & Storage	x	x														
Marketing Skills																
1. Interest Inventory	x	x											x			x
2. Values Inventory	x	x														
3. Skills Inventory	x	x											x			
4. Communication Skills	x	x	x													
5. Individual Job Goals	x	x														
6. Telephone Techniques	x	x	x													
7. Bus. Letter Guidelines	x	x														
8. Interview Preparation	x	x	x													
9. Sourcing for Employment	x	x												x		
10. Group Resume Writing	x	x														
11. Indiv. Resume Writing	x	x														
12. Employment Applications	x	x														
13. Grp. Cover Letter Develop.	x	x														
14. Individual Cover Letters	x	x														
15. Individual Job Search Plan	x	x														
16. Oral Employment Tests	x	x	x													
17. Written Employment Tests	x	x				x										
18. Individ. Employ. Interviews	x	x	x													
19. Employment Offer Evaluation	x	x														x
Quality																
1. Intro to Qual. Terms & Conc.	x	x											x		x	
2. Intro to Statistics	x	x				x	x			x	x			x		
3. Prelim. Design Review	x	x	x			x			x							
4. Product Qualif. Tests	x	x				x				x	x					
5. Material Specifications	x	x				x										
6. Production Quality Control	x	x				x					x			x	x	
7. Product/Process Inspection	x	x				x									x	
8. Non-Conform. Parts Disposal	x	x				x										
9. Pkg. & Ship. Quality Control	x	x				x							x			
10. Customer Satisfac. & Service	x	x	x													
11. Product Liability	x	x														
12. Clms., Cmplts. & Prod. Recall	x	x	x													x
13. Qual. Cost Improv. Projects	x	x				x				x	x					